PERCEPTUAL INTERFACES FROM THE PERSPECTIVE OF HUMAN-COMPUTER INTERACTION AND ITS USE IN EDUCATION

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ABSTRACT: The human-computer interaction is a hot topic because of the considerable increase in the production and use of information and communication technologies. In this interaction context, new generation interaction styles have emerged by the constant advancements in the technology. One of these interaction styles is perceptual interfaces that contain different kinds of high level natural interaction. This interaction is based on natural human-human interaction style like gestures, touching and speaking. The purpose of this research is that to examine perceptual interfaces in the perspective of human-computer interaction and infer some results about how to use them in education and offer suggestions about it. In this study, interaction design of the perceptual interfaces was discussed according to the reviewed literature. Also, motion-based technologies, used in these interfaces, were presented and use of these technologies in the field of educational technologies was examined. It is considered that the results of the study can provide guidance to researchers and practitioners. There are many types of perceptual user interface interaction. Today, the most popular application area of the motion-based technology is Kinect technology. This technology includes a variety of perceptual interaction such as; image viewing, skeletal detection and monitoring system. Kinect technology is one of the most popular devices in the field of image processing technology that can detect movements and send these to computers. Kinect technology was developed by Microsoft to play digital games with Xbox console and it has been used in other areas as time goes by. Although this technology originally developed for digital games, it has often begun to be used in scientific researches by the capability of catching depth of an image. By considering that perceptual interfaces can provide natural interaction to individuals like in their social life, users can exhibit their skills without extreme cognitive load and they can learn easier via perceptual interfaces. In this context, it is envisaged that perceptual interfaces can support learning by providing ease of use and control.

Key words: Natural user interfaces, perceptual interfaces, motion based technologies, kinect technologies, educational technologies

INTRODUCTION

We use many different products for various goals in daily life. Everything which exists with these products is in interaction with each other (Dix, Finlay, Abowd & Beale, 2004). Thus, the interaction of a product with human should be considered if its design is demanded to be used (Olson & Olson, 2003). Interaction is defined as the response from a case or affecting each other mutually (Dix, Finlay, Abowd & Beale, 2004). Number and variety of interaction between human and technological products increase as a result of rapid increase in the production and usage of information and communication technologies. The concept of human-computer interaction started to be a matter of many scientific researches on this generated new case. Cagiltay (2005) defines the interaction between human-computer as an interdisciplinary study field concerning in the interactive technologies' design, evaluation and application. One of fields that the interactive technologies are used within the scope of this definition is education. Stephanidis, Kouroumalis & Antona (2012) defend that the interaction needs to be considered within the sense of relation between "new media" and "educational technologies". These technologies require to be designed to meet users' needs (learners) in the easiest way (Norman & Draper, 1986) in order that new media usage in educational technologies contributes to learning environment.

The rising generation interaction styles which have occurred with the developing technologies in the field of human-computer interaction have got important role in the design of new media which will be used in educational technologies. Some of this rising generation interaction styles are; virtual reality, augmented reality, ubiquitous or pervasive interaction, tangible user interfaces, embodied interfaces, lightweight, tacit, passive, implicit or noncommand interaction, perceptual interfaces, affective computing, context-aware interfaces, ambient interfaces, wearable computing, sensing interfaces, eye-movement based interaction, speech or multi-modal interfaces, brain-computer interfaces. The focal point of this research is to comprise the useful of perceptual interfaces from these styles in the field of educational technologies.

Perceptual Interfaces

Sense is defined as the case that individual is aware of an object, quality or events which stimulate the individual with help of sense organs (Inceoglu, 2010; Morgan, 1984). Perception is defined as matching mental components with data from senses and being able to understand goings-on in an environment (Aral, 2000). Perceptual psychology defends that human's experiences consist as a result of senses' stimulation (Goldstein, 1989). Sense is classified by five senses as visual, dimensional, aural, olfactive, tactile (Caglayan, Korkmaz & Oktem, 2014). In another saying, perception can be defined as a case which occurs as a result of the interaction between individuals and living or nonliving assets around them. Accordingly, human may interact with computers in a similar way with their interaction between each other and physical world. Sociology and psychology sciences determined that human interacts with computer and other communication technologies with social and natural ways (Reeves & Nass, 1996). Additionally, human perceives the environment by sense organs for the human-human interaction and also human-computer interaction (Sharma, Pavlovic & Huang, 1998).

Perceptual interfaces are structures which provide opportunity to be interacted with user in more than one channel. While the user interacts only with writing or the help of mouse in traditional interfaces, interactions such as speaking, touching, mimics take place in perceptual interfaces additionally. Perceptual user interfaces which present high interaction and varieties were modelled in the base of natural interactions between human and human. For example, seeing, hearing, touching, speaking etc. (Turk & Robertson, 2000). Additionally, perceptual user interfaces require the integration of many technologies which perceive sound and speech, include graphics animation and visuals, perceive the sense of touching and provide feedback (Turk & Kolsch 2003; Geng, Strauss, Fleischmann, Elistratov & Kolesnik, 2003). In that vein, Turkoglu (2010) argues that actions which doing, hearing, seeing and speaking functions are simultaneously used make the learning more permanent.

The point to be considered was emphasized on how people's perceptual experiences work, how machineries would change and impair people's sense (Reeves & Nass, 2000). The process between people's acts and computers' perceiving these acts was showed at Table 1 (Geng et al., 2003; Sharma, Pavlovic & Huang, 1998). Additionally, Turk & Robertson (2000) stated that another goal of perceptual interfaces is to give opportunity to individuals to transfer their social skills by providing natural environment such as their social life without being exposed to extensive cognitive load.

Table 1: Modalities mapping between human action and computer sensing (Geng vd., 2003; Sharma, Pavlovic & Huang, 1998).

Human Action Modalities	**Device**	**Computer Sensing Modalities**
Typing, Handwriting, Pushing and Clicking, Gloved-Hand Gestures	Keyboard, Tablet, Mouse, Glove, etc.	Position/Motion
Speaking	Microphone, Voice Recognition and Synthesis	Audio
Body Movement Head Movement Free hand gestures Facial expression	Camera, Vision-Based Tracking & Recognition	Video
Eye Movement	Eye-Tracking System	Video
Hand Pressure	Haptic Device	Tactile/Force
Brain-activity	EEG	Neural

Usage Areas of Perceptual Interfaces

The literature related to the usage fields of perceptual interfaces is reviewed, it is seen that this interaction style is used in many fields Geng et al. (2003) indicate on their research that perceptual interfaces give opportunity to people to shop virtually from a shopping center as they do not shop physically. In this study, it was reviewed how people would shop with the use of a device like a treadmill that they would control with 3-dimensional navigations and gestures.

Students' motivation is one of the most important factors in the learning process. Students' motivation is measured by surveys in traditional methods, but these kinds of measurements are not proper in game-based learning as the concentration of person who plays game is affected negatively. The study which was done by Ghergulescu & Muntean (2014) aimed to measure students' motivation with a perceptive-based measurement method with the help of EEG without disturbing player. This study which was conducted by 48 persons that their ages change at the range of 18-55 was applied to all of them and took 45 minutes. Consequently, it revealed that the application of survey was not efficient to measure users' motivation but a perceptive-based measurement method measured their motivation better (Ghergulescu & Muntean, 2014).

As reading includes complex cognitive processes, it is difficult to determine on students' development with observations. E-books are indicated as a way to explanations students' reading difficulties and weaknesses. It is aimed that students' reading behaviors are observed with the help of touch-operated interfaces and e-books. 3 phases were followed in a research which was done for it; 1) the analysis of real classroom conditions, 2) the design and application of system, 3) the evaluation of system's availability and functionality. Students' reading process were recorded in the base of an algorithm with the help of a touch screen and web camera in this study which was done with 15 persons. Consequently, reading process which its determination was difficult by being observed was determined in an easier way with the help of this record (Huang, Hsu, Su & Liu, 2014).

In another study, which aimed to measure cognitive load from mimics, cases of 20 persons to make mental mathematical processes were measured with a camera put on computers' top and some devices (ECG, SC, BIOPAC, MP1502 & RESP) put in participants. Results show that it was considerably succeeded to determine on factors of using face modelling causing cognitive load while cognitive load was measured (Hussain, Calvo & Chen, 2014).

In another research, which aimed to measure effects of different methods with their matching as visual/tactile, visual/aural, visual/aural/tactile, total 26 university students that 12 of them are females and 14 of them are males were studied. Trainings were applied to students in 3-dimensional areas that consist of three different combination in double groups, that (1) are visual and tactile which users see and feel interface, (2) they see and hear interface, (3) users see, touch, hear interface. In these areas; it was asked from them to position cubes in cells on a screen. The application was recorded in a video in order to evaluate the process and a survey was used to users. Results indicated that interfaces which visual/aural/tactile factors were used together increased the students' awareness on environment and also provided that they felt themselves much more in safe (Moll, Pysander, Eklundh & Hellström, 2013).

In similar way, in another study which aimed to determine on users' psychological and so sense case with the help of visual and aural stimulus, total 24 university students whose ages change in 20-30 years were studied. Users indications such as psychological signals, mimics, breathing were examined with the help of 24 visual and 24 aural factors which their validity was proved (IAPS visual, IADS aural) as they were recorded by method with the aim to measure sense such as electromyogram and electroencephalography. Those records were done as the system perceived image and sound. Results indicated that aural stimulus was more effective than visual stimulus on perceptual interfaces (Zhou, Qu, Jiao & Helander, 2014).

Bickmor & Cassell (2004) developed the embodied conversation agents (ECAs), using robots and imaginary avatars in order to make a face-to-face communication. Users are asked to read the short letter and to reply 3 questions related to the letter that they read, in each phase of 3-phase study that Morency, Sidner, Lee & Darrell (2007) developed it using these agents. Each of texts and questions presented to users differ in each phases. All of participants have got the skill to use mouse and keyboard in the study that 19 persons attended but none of them have used a technology which would be controlled by gestures. While 12 of participants attended in first two phases, 7 of them attended in each of 3 phases. Each of phases took nearly 2-3 minutes. At the end of each phase, participants were asked to reply question to evaluate keyboard, mouse and the system that they used their gestures. 2 questions in five-point likert type were asked and the natural usage and effectiveness of these three applications were tried to be measured. Participants were asked to choose pdf document with the help of mouse or keyboard in the first phase of the experiment, to choose it with the use of gestures in the second phase and to prefer one of the system that they used mouse, keyboard and their gestures in the third phase. As a result of the research, it was determined that the technology which would be controlled by gestures was more effective.

As it was mentioned on the relevant literature, there are many perceptual interface interaction varieties. Today, the most popular application field is Kinect technology. This technology includes varieties of perceptual interaction such as monitor image, perceiving and monitoring system for frame.

Kinect Technology

Kinect which is one of the most popular devices at the field of image technology and which would send people's gestures to computers after perceiving them was developed by Microsoft in order that games are played by Xbox game console and its usage has become spread in other field in time. Even though this technology which includes perceptual interaction was firstly produced in the purpose of game, it started to be used often in scientific studies as depth image would be taken.

While left eye of Kinect (Fig. 1) which has got a mike on it, a motor mechanism to provide gesture and three eyes make laser projection, infrared sensor on right informs the distance of each point as calculating arrival-going period of these rays. In light of this data, the software in Kinect sends data to Xbox or computer after calculating the structure of frame (Colvin, Babcock, Forrest, Stuart, Tonnemacher & Wang, 2011). The eye in the middle of Kinect is a 30 FPS (Frame Per Second) VGA (Video Graphics Array) camera with 640 x 480 resolution. The image which is gotten is sent to the application as photos for 30 times in a second (Stowers & Hayes, 2011). Moreover, Kinect sends data that it gets with the use of sensors to the natural interface's library of user as sound, image and depth, and sends to applications after interpreting them here (Colak, Yuksel, Sunguray & Gumus, 2013).

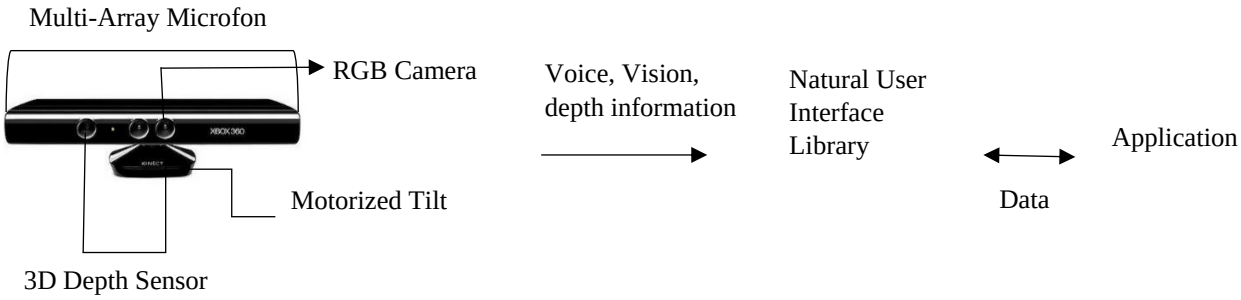

Figure 1. Kinect technology and data flow direction (Colak, Yuksel, Sunguray ve Gumus, 2013)

Another property of Kinect technology is the perceiving and monitoring system for frame (Fig. 2). Infrared camera spreads rays of infrared into the area as the command of gesture perception is given and so 20 different starting points in people's body are perceived and monitored (Sidik, Sunar, İsmail & Mokhtar, 2011; Ikemura & Fujiyoshi, 2011). If the act which is done is an act registered in ROM's of Kinect, a warning code is sent to computer by the system. If it is not available between gesture-defined gestures which are done, Kinect keeps the system for waiting (Tong, Zhou, Pan & Yan, 2012).

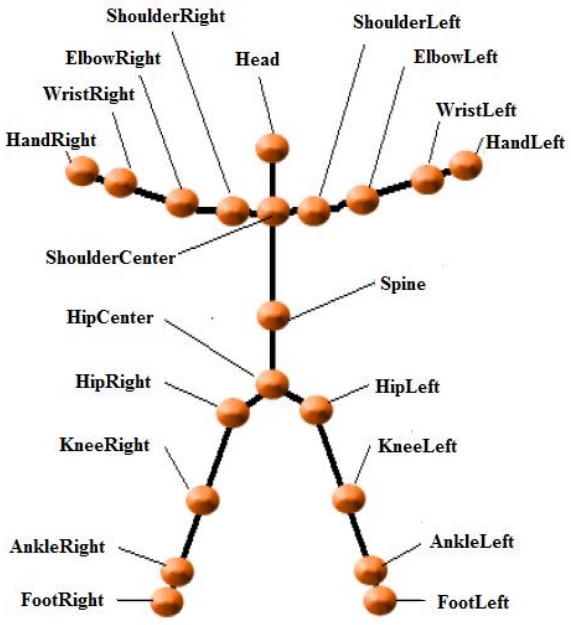

Figure 2. Microsoft KinectTM joint points (Colak, Yuksel, Sunguray & Gumuş, 2013)

Usage Areas of Kinect Technology

On a study, which was done to measure the console of Microsoft giving opportunity with hand and arm gestures, Kinect technology and mouse's usability; 10 persons used mouse and 10 persons Kinect technology having motion-based interaction opportunity as using MetricSPlat which is software that information is visualized. It was concluded that Kinect technology is more effective (to provide a natural interaction) in measurements which are done by the usability test (Libardi, Traina & Rodrigues, 2014).

Chang, Chen & Huang (2011) stated that the learning environments which are done with the use of Kinect technology are helpful to get daily life skills for students and to transfer them to real life. Tenekeci & Gumuscu (2016) made two-phased study with the application which was done on the use of Latin characters used in Turkish for first reading and writing training. A screen was prepared in order to promote letter in the first phase of application. If the frame information belonging to person using the application comes on the letter that it demands as being interpreted by the program and waits sufficiently, it is provided that this letter is sent to the used aurally. The child wants to listen to whichever letter's name again, it is necessary to come on that letter and then to wait on the definite icon for a definite period. On the second phase, a screen which the child learning letters would test himself was developed. On this screen, names of letters are randomly listened to the user and the student is asked to come on the letter's icon that he listens to it and then to stop in a definite period. If the student answers correctly, new letter is asked after he is congratulated, if he chosen incorrect one, he is asked to try again as he is said that his selection is incorrect. In the next phase, the application based on the procedure to wait or not to wait for one of hands on any letter in a definite period is coded as the frame data from Kinect is interpreted.

Some applications such as calculator, music orchestra settlement, the settlement of organs in people's body and management of PowerPoint presentation that the user would use all of applications as running without having any contact with the use of a training application which was developed in Microsoft Visual Studio platform and with the use of Kinect technology were developed. While a presentation is provided to work, and be managed in an automatic way by sound as properties of sound are added to open the presentation in procedures of presentation, the same procedures were provided to be controlled in a contact-free way also. As it was aimed that users learn with much more doing in the training application, Kinect Software Development Kit (SDK) which its use was tried to be kept simply was used (Colak, Yuksel, Sunguray & Gumus, 2013).

Hsu (2011) considered Kinect in terms of two points. First of them is that Kinect will increase students' motivation as making courses more enjoyable and will create a stimulus effect on the student in the case that a course plan and courses' interaction are designed carefully. The second one is that Kinect would substitute of a learning tool that students would create their own information as it is used like an educational software in a way that the educational softwares contribute to students to create their own information. Moreover, Kinect which increases the interaction and participation in the classroom supports that teachers make discussion in the classroom by using multimedia and also it provides that the skills of interaction increase (Hsu, 2011).

CONCLUSION AND DISCUSSION

When it is considered that people have interaction with computer and other communication technologies and social and natural ways, people have interacted with computers in a similar way that they interact with each other and physical world (Reeves & Nass, 1996). When it is considered that perceptual interfaces provide a natural interaction for individuals like their social life, it is thought that users would exhibit their skills without having extensive cognitive load and they would learn in an easier way thanks to perceptual interfaces (Turk & Robertson, 2000). In this sense, it is estimated that the use of perceptual interface provides the easy to use and control, and would support the learning. For example, it can be helped to pre-school children who try to get daily life skills newly about preparing a learning environment, gaining daily life skills and transferring them into real life as using Kinect technology. Additionally, when it is thought that pre-school children would learn better in learning by doing activities, the learning environment would be enriched as Kinect technology which its use is tried to be kept in a quite simple way is used.

The interaction between human-product should be definitely considered in order to provide the use of perceptual interfaces and easy for its control (Olson & Olson, 2003) and it should be paid attention on how perceptual experiences work, how machineries would change people's perception and would improve them (Reeves & Nass, 2000). There are seen some advantages and disadvantages related to the use in education.

More effective perceptual user would be designed as goals that Preece, Rogers & Sharp (2002) stated them while telling the topic "User-Interface Design and Usability" are considered, it can be provided with the designed

perceptual interface that the interaction between student or teacher is increased (to take the product- user interaction to the optimum level), so that the product is easily used (to develop usable products) and lastly the designed perceptual interface meets users' needs as giving natural interfaces (to meet the product users' needs and experiences). For example, Kinect technology can raise the interaction and participation in class as a support for teacher to take discussion in class as using multimedia. Moreover, it can be provided that interaction skills such as student-student, teacher-student, teacher-technology and student-technology increase. The suitability of this product's design can be interpreted as usability of this product and in what extend it interacts with user. While it designs perceptual interface for education, the points such that the use of designed interface is easily learned by user (learnability), it provides benefit for user and reinforces the learning (efficiency), users would remember easily the use of perceptual interface (memorability), the user estimates faults that they are possible to do as using perceptual interfaces (how severe are errors) and the user is satisfied with the use of perceptual interface during the training (satisfaction) should be paid attention (Nielsen, 1993). Systems' design goal is to provide easy and effective use for users. So, interface designs require to meet users' needs in the easiest way (Norman & Draper, 1986).

It is at the main of perceptual interfaces' advantages that it provides opportunity for users to have interaction with user in more than one channel (Turk & Robertson, 2000). Moreover, it is considered that individuals understand complex cases in easier way when they use their three-dimensioned motor skills (Hsu, 2011). In this sense, it is considered that the use of perceptual interface provides the usage and control easiness for individuals and it will support the learning. While the user has interacted only with writing and the help of mouse in the traditional interfaces interactions such as speaking, touching, mimics take place in perceptual interfaces additionally. Turkoglu (2010) argues that actions which doing, hearing, touching, seeing and speaking functions are simultaneously used are more permanent for users. Similarly, as methods which would be controlled by gestures provide natural interaction, it was determined that it is more effective than methods that tools such as mouse and keyboard are used (Libardi, Traina & Rodrigues, 2014; Tong, Zhou, Pan, & Yan, 2012). For example, words which are demanded to be taught to the user can be previously identified to Kinect technology as a perceptual interface is designed for individuals who want to take a sign language training with the distance education. When it is considered that gestures and mimics have got very big importance in sign language, users should be informed as it is determined on whether individuals pronounce or don't pronounce correctly words in sign language with the help of Kinect.

Waibel (2006) mentions that perceptual interfaces are smart tool to make interaction easy further to that they would not be seen only as data input tools only substituting keyboard. He states that this advantage provides that interfaces in daily applications are proactive, social and much more in the work but two problems are seen in this scope. First of these problems is comparative linguistic communication which is supported by machineries and the second one is computers which provide services taking base the observed and perceived needs rather than people's observable direct interactions for people's interaction cycle. For example; Kinect technology would be used on whether individuals pronounce words correctly in foreign language learning and to teach them if they pronounce them incorrectly so how to pronounce them correctly. Even the same function seems to be done on a computer program at first look, more detailed training and evaluation can be done as Kinect technology has got a property to perceive gestures and mimics.

As perceptual interfaces, present natural environments for individuals such as their social life (Turk & Robertson, 2000), individuals would gain social skills in easier way and they would easily transfer their information without having extensive cognitive load. In this sense, using face modelling can provide easiness to determine on factors causing cognitive load while cognitive load is measured (Hussain, Calvo & Chen, 2014). Similarly, students' development can be determined in easier way with the help of touch-operated interfaces in the cases which include complex cognitive processes such as reading (Huang, Hsu, Su & Liu, 2014). For example, e-books are showed as a way to explain students' reading difficulties and weaknesses. It is aimed to observe students' reading behaviors with the help of touch-operated interfaces and e-books.

As the survey applications are inefficient to make users' motivation measurement (Ghergulescu & Muntean, 2014), method which would do measurements automatically after perceiving the user's gestures can be preferred for a healthier measurement. Furthermore, perceptual interfaces provide opportunity for individuals to necessary activities virtually in an area that they are not available physically. For example; a person can go to a shop virtually and shop as acting like being in a real market without going to a market physically (Geng et al., 2003). The more important is that it can be provided for individuals to have got an experience very close to real one in medical and piloting trainings which their error margin is 0%. So, a medical student has got chance to experience possible cases previously in the closest way to real one as having a heart operation. This case is valid for piloting trainings also.

Moreover, Pentland (1999) mentions that many objects which we use in our daily life such as table, car and shoes cannot have interaction sufficiently with individuals, so they are restricted to be useful and meet their needs. Thus, it is emphasized that smart classes would be designed without depending on devices such as keyboard and mouse as technologies to follow individuals' gestures and perceive their face, mimics and expressions. According to principles of accessibility, it is necessary that the training gives opportunity to different learning environments and supports the individualized training. The perceptual interfaces can be used to make these environments (Burzagli, Emiliani & Grazian, 2004). Similarly, the learning environment was described as a smart environment which was reconstructed and integrated into other smart environments, in the scenario named with "Annette and Salomon-environments for social learning" that Ducatel, Bogdanowicz, Scapolo, Leijten & Burgelman (2001) prepared it. In this sense, many new technologies were developed in the event that the learning environment is provided to be integrated in other smart environments. Perceptual interfaces are accepted one of these technologies to provide this integration and make smart classes. For example, an experiment which has danger to be done in laboratory area can be done in the classroom with the help of Kinect technology as students are taken to the board. So, it will be provided that students construct their own information and also students' motivation will increase because the stimulus effect will raise in the student.

Perceptual user interfaces require the use of technologies together which perceive speaking and touch sense, provide feedback and include graphics animation and visuals (Turk & Kölsch 2003; Geng et al., 2003). Additionally, perceptual user interfaces which would reach wider target groups and would reach sense organs in order to raise usability should be developed in consideration that sense is classified by five senses as visual, dimensional, aural, olfactive and tactile (Caglayan, Korkmaz & Oktem, 2014). Even if it is included in the literature that the use of visual/aural/tactile factors together increases the students' awareness on environment and provides that they feel themselves in safe (Moll, Pysander, Eklundh & Hellström, 2013), it should be paid attention that a cognitive load is not caused in the user as using unnecessary many factors together.

One of the restrictions in Kinect technology is that it would perceive only 20 different parts in people. In this case, if the gesture that the user makes is not a registered one, it is not perceived by the system (Tong, Zhou, Pan & Yan, 2012; Suzen & Tasdelen, 2013). The raising generation interaction styles are used in many experiment environments with its structure. When this interaction styles go out if experimental environments and then takes in real applications, there would be problems in the integration, operability and compliance between objects and devices. Moreover, security and privacy topics come up as environment and devices more than one have got contact with each other. Additionally, as these environments need an environment with constant internet (Wireless or Mobile access), it increases the cost of this technology (Stephanidis, Kouroumalis & Antona, 2012). Furthermore, there are other restrictions; a wide application area is necessary in classroom during the use of Kinect and programs which would be used with Kinect technology are not efficient (Hsu, 2011).

When results of the relevant researches are considered, it can be said that technologies which provide the user to have one-to-one interaction with the system have got much more effect on learning (Preece, Rogers & Sharp, 2002). Another result is to be concluded that; as we increase the integration with user so the technology will provide benefit for the user in that scale (Preece, Rogers & Sharp, 2002). Moreover, it is stated that multiple-choice surveys are not sufficient always to measure the usability of a designed system, perceptual measurements which will be done without interrupting the interaction process of users will be more beneficial when the interaction is especially wanted to be measured (Ghergulescu & Muntean, 2014).

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