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The Impact of the 4th Industrial Revolution on Engineering Education

Proceedings of the 22nd International
Conference on Interactive
Collaborative Learning (ICL2019) –
Volume 1

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Panarit Sethakul
Editors

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Conference on Interactive Collaborative
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 Springer

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Preface

ICL2019 was the 22nd edition of the International Conference on Interactive Collaborative Learning and the 48th edition of the IGIP International Conference on Engineering Pedagogy.

This interdisciplinary conference aims to focus on the exchange of relevant trends and research results as well as the presentation of practical experiences in interactive collaborative learning and engineering pedagogy.

ICL2019 has been organized by King Mongkut's University of Technology North Bangkok from September 25 to 27, 2019, in Thailand.

This year's theme of the conference was "The Impact of the 4th Industrial Revolution on Engineering Education."

Again outstanding scientists from around the world accepted the invitation for keynote speeches:

- Xavier Fouger, Senior Director, Learning Centers and Programs, Dassault Systemes – Learning Experience. Speech title: *Learning Centers*, a Tidal Wave in Shaping the Workforce of the Future
- Doru Ursutiu, Manager of Center for Valorization and Transfer of Competence, "Transylvania" University of Brasov, Romania. Speech title: Affective Education and New Technologies starting from Music Therapy to Engineering Education!
- Stefan Vorbach, Professor at Graz University of Technology, Graz, Austria. Speech title: The Importance of Entrepreneurship Education for University Graduates
- Aditad Vasinonta, Deputy-Director General, Office of Industrial Economics, Ministry of Industry, Thailand

In addition, an invited speech has been given by

- David Guralnick, Kaleidoscope Learning, USA. Speech title: Creative Approaches to Online Learning Design

Furthermore, five very interesting workshops have been held:

- Methodologies To Build Conceptual Questions For Assessing Important Misconceptions In Engineering-Related Areas
- Getting Ready for IT Program Accreditation in Europe: the Euro-Inf Standard
- Introduction to Modus Toolbox™ IDE Using PSoC® 6 MCUs
- Authentic Learning Strategies to Develop Engineering Competencies for the Twenty-First Century
- Employing Accreditation Requirements to Build Engineering Leadership Components in the Curriculum

Since its beginning, this conference is devoted to new approaches in learning with a focus on collaborative learning and engineering education. We are currently witnessing a significant transformation in the development of education. There are at least three essential and challenging elements of this transformation process that have to be tackled in education:

- The impact of globalization and digitalization on all areas of human life
- The exponential acceleration of the developments in technology as well as of the global markets and the necessity of flexibility and agility in education
- The new generation of students, who are always online and do not know to live without Internet

Therefore, the following main themes have been discussed in detail:

- Interactive and Collaborative Learning
- New Learning Models and Applications
- Research in Engineering Pedagogy
- E-Learning and Distance Learning
- Problem and Project-Based Learning
- Course and Curriculum Development
- Knowledge Management and Learning
- Real-World Learning Experiences
- Evaluation and Outcome Assessment
- Computer-Aided Language Learning
- Vocational Education Development
- Technical Teacher Training

As submission types have been accepted:

- Full Paper, Short Paper
- Work in Progress, Poster
- Special Sessions
- Round Table Discussions, Workshops, Tutorials

All contributions were subjected to a double-blind review. The review process was very competitive. We had to review nearly 570 submissions. A team of about 275 reviewers did this terrific job. Our special thanks to all of them.

Due to the time and conference schedule restrictions, we could finally accept only the best 166 submissions for presentation.

Our conference had again more than 200 participants from 38 countries from all continents.

ICL2020 will be held in Tallinn, Estonia.

Michael E. Auer
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Video Games and Their Correlation to Empathy

How to Teach and Experience Empathic Emotion

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Abstract. This article focuses on how video games may trigger empathy. On the one hand, globalization and our fast-changing, globalized world have resulted in an empathy deficit, a situation that calls desperately for a new approach to tackle the empathy issue. On the other hand, recent statistical data has shown that players in some countries today spend on average more than 4 h weekly playing games. Most past research has found that playing violent games decreases pro-social behavior. However, only a few studies investigate the effects of neutral or pro-social video games. Our study aims to identify several characteristics of four games that seem to promote positive moral and empathy and involves 40 subjects. Specifically, we look into the effects of variation of number of interventions and the correlation with perceived presence and immersion. The research reported in this paper covers background and related work on empathy research, existing work on video games for experiencing empathy and the layout of the study. The findings of this initial study on four pro-social games suggest that sufficient story-line of video games can positively impacts aspects such as the ‘perspective taking’ of players. Findings also indicate that multiple interventions and higher perceived immersion dent to increase the level of empathy. This research may contribute to supporting the promotion and development of the ‘*games for good*’ or ‘*games for change*’ campaign.

Keywords: Empathy · Pro-social · Video games · Immersive · Presence

1 Introduction

Empathy is an essential skill, which is of growing importance in our modern and globalized society. Empathy helps persons to cope with interpersonal conflicts both at home and work. It helps us to understand non-verbal communication and supports us to predict the actions and reactions of other people more accurately. Empathy allows us to become happier and can lead to greater personal and

professional success (Mc. Donald and Messinger 2011). However, research has also shown that empathy levels have diminished as a result of lifestyle changes. This includes elements such as an increased “screen-time”, information overload, and lack of attention to character or moral development in primary education (Elmore and Harden 2013). Exploring ways to experience and teach empathic emotions are thus becoming increasingly important (Dohrenwend 2018).

Empathy experiences can be triggered by watching movies, reading (fiction) literature, consuming storytelling content, and playing video games or simulators. Mark (2019) stated that *“A book or movie can show us what it is like to be in a character’s shoes, but it is the video game that can put us into those shoes”*. Although several games related to empathy have been built and released, there is still a lack of evidence that they are a sufficient tool for teaching and experiencing empathy and to link the game experience to real life situations. Most video games do not create empathy, because their chosen storylines do not trigger deep psychological involvement in the characterization (Manney 2008). In response to this it is thus important to analyze those media and applications, which are known to create empathy and to identify the elements, which can be used as design tools to create experiences that do trigger empathy.

The relevance of empathy research in the game domain is supported by statistics showing that people in some countries, such as the USA, the UK, France, Japan, and South Korea, spend more than 4h a week playing video games. It was found that among the countries studied, UK gamers spend 7,5h a week playing video games, while South Korean gamers spend an average of 4,42h a week on playing games (Gough 2019). More than 2,5 billion people worldwide play video games (TGGMR 2016).

Video games are often blamed as being a cause of addiction, aggression, and anti-social behavior and many studies have examined correlations between violent behavior and video games with results that are often highly controversial and diverse. Anderson and Warburton (2012), for instance, claim that indicators of aggression are positively related to video game violence exposure. According to a study by Krahe and Moeler (2010), playing violent video games, increases physical aggression and reduces affective empathy.

In contrast, several studies also show that there is no link between violent behavior and the playing of video games. The Oxford University researchers Przybylski and Weinstein (2019) showed on the basis of a study with 1004 participants who play violent video games that there is no evidence for relating violent game engagement to aggressive behavior.

Nevertheless, playing a video game or watching a movie triggers emotions and these media can be used as a powerful tool to trigger empathy. Greitemeyer et al. (2010) explored the effect of playing video games on empathy and pleasure taken in the misfortune of another person (“schadenfreude” or malicious joy is the German term for this). Their research showed that playing pro-social video games can decrease antisocial aspects and increase the pro-social aspects. Furthermore, they found that exposure to pro-social video games can strengthen interpersonal empathy and also reduce schadenfreude. The research and development of digital games

for teaching prosocial and moral development are still limited and in an early stage. More research is needed to understand the potential digital games have for supporting specific learning outcomes. A study on Philosophy by Coeckelbergh (2007) stated that empirical research is required on the relation between moral development and games in terms of empathy and cosmopolitanism. In this context it is thus essential to explore and discuss further the potential of immersive video games to trigger empathy.

Many pedagogical experts believe that promising methods exist for using technologies such as web-based applications, interactive media, and games to teach empathy. They suggest resources and technologies which are already available and used by young people should be explored and dedicated to promoting empathy in order to turn away from the trends of narcissism, loneliness, and isolation. In this paper we thus aim at investigating the potential of video games for teaching and experiencing empathy in order to address our main research question, which concerns the characteristics of games that promote positive moral and social behavior in the context of empathic abilities.

2 Empathy and Video Games

The popularity of video games has triggered concern among educators, policymakers and parents. Studies have been conducted in the pedagogical field that investigate the correlation between games and empathy. Most educators who have invited students to play video games have done so as a means of allowing students to experience the value of understanding the perspective of other people.

2.1 Empathy

Empathy can be defined in many contexts and definitions. In general terms, empathy is the ability to sense other people's emotions, coupled with the ability to imagine what someone else might be thinking or feeling. It also defines the understanding and sharing the emotional state of another person, the projection of one's own personality into the personality of this other person and to feel with the heart, see with the eyes, and listen with the ears of another person (Batson et al. 1997; Eisenberg and Eggum 2009).

According to Davis (1980), empathy has four components: *empathic concern* is an other-oriented feeling of concern for the misfortunes of other people and a sense of sympathy with them. *Fantasy* is a respondent's tendency to transpose themselves imaginatively into the emotions and actions of fictitious characters in books, movies, or plays. *Personal distress* is a self-oriented feeling of personal anxiety and unease intense in interpersonal settings. *Perspective taking* is the tendency to adopt the psychological point of view of others spontaneously.

In a study which explores immersion in persuasive games, the authors found that immersion creates stronger emotion and deeply personal experiences (Hafner and Jansz 2018). Furthermore, the result of this study suggests a positive relationship between immersion and narratives in interactive media that support

player involvement. Their research was focused on persuasive games which target social impacts such as conflict resolution, humanitarian crisis, poverty, war, and terrorism. They found that narrative depth, identification, and perceived realism contribute to the players' immersive experiences.

2.2 Empathy in Video Games

Huizinga (1983) defines games as *“an activity which proceeds within certain limits of time and space, in a visible order, according to rules freely accepted, and outside the sphere of necessity or material utility. The play-mood is one of rapture and enthusiasm and is sacred or festive by the occasion. A feeling of exaltation and tension accompanies the action, mirth and relaxation follow”*.

Only limited research has been conducted into exploring the effect of playing pro-social games and the influence this has on behavior, the attitude of players, or moral development such as emotional intelligence or empathic ability (Happ 2013). Empathy has been explored as a mediator for pro-social behavior in a video games context (Prot et al. 2014). In the research area of psychology, the role of empathy as a moderator between the behavior and the corresponding different social situations of the participants has been studied (Watson 2016). In a couple of studies, the participants were invited to imagine what someone else or they themselves would feel like in a specific situation (Batson et al. 1997).

On the other hand, the rise of an empathy games genre has triggered some interesting issues about how exactly player should playing them and players' psychological responses to these games (Solberg 2016). “Empathy games” appear to have a great potential for raising awareness about various real-world issues. In the past two decades news reports have been warned of the dangers implicit in video games. By contrast, Gee (2008) asserted that games embody many of the promising features that should be sought in learning environments.

Research has been conducted in many directions to investigate positive effect of serious games. One philosophy study on computer games suggested that the fundamentals of affects in computer games are goal status evaluations and empathy with game characters (Lankoski 2007). Furthermore, Lankoski stated that games with characters can influence the emotions of players using affective simulation and the affective expressions of characters where the implied goals take a primary role.

A research of Bachen et al. (2012) examines the impact of ‘real life’ games that help players to develop inter-cultural knowledge on global empathy. Players acquire experience of what a life could be like in another country, educational system, or when faced with diseases and natural disaster, and in the process they identify with and experience other countries. Cognitive experiences and development might affect the development of experience of global empathy (Bachen et al. 2012)

Another study by Vaughan et al. (2011) investigated effectiveness of gaming in bullying behavior. In this research, computer games are used as bullying prevention tools that provide individualized and cumulative learning of pro-social, attitudes and social skills, which may help to abate bullying behavior and shift

the social norms into class. They stated that educational gaming is developing as a promising area that promotes the effectiveness of an early bullying prevention program for elementary school students. This program will help pupils to develop healthy social relationships throughout their lives.

Happ (2013) found that pro-social game content stirs pro-social behavior and that the effect of empathy depends mainly on the game outcome and the game character. A study by Heron and Belford (2014) stated that there are considerable question marks as to whether games can realistically have any genuine impact on the moral perspective of the players. Furthermore, he stated that more studies are needed to specify whether and how games can support and develop empathy.

A study has been conducted to find the potential of serious games for mental heart treatment. One of the analyzed games, ‘That Dragon Cancer’, tells the true story of a five years old child who died due to terminal cancer. His parents developed this game to describe the experience of having a child diagnosed with cancer. This game features spoken word poetry, and themes of faith, hope, despair, helplessness and love which may affect the emotions. The mother Amy Green argued for art therapy. She concluded that video games are an important art form and that they are very useful in this area. Furthermore, Green stated that “People focus on the unproductive escapism in games, but that inherent abstraction can help us to experience someone else private grief” (Miller 2015). Miller suggested that further research in this area is both promising and necessary.

The puzzle game ‘Old Man’s Journey’ was mentioned in the list of ‘games we need’ by the screen therapy blog which is dedicated to exploring how players can use the time they spend on games to strengthen their emotional intelligence. This game has not only received a couple of awards for its excellent visuals like the ‘Apple Design Award’, but also for the narrative techniques it uses like the ‘Emotional Games Award’. This is due to the fact that this game triggers empathy as it lets the player feel with the old man, who puts a lot of effort into reaching his grandchild. Old Man’s Journey is an adventure game which tells the life story of an old fisherman who lives in a seaside village, his precious moments and his losses. This game communicates profound feelings of hope, bliss and regret. In other words, this game has ‘emotional impact’ on the feelings of players (Ann 2018).

Another study on the perspective of moral game design has been conducted by de Smale et al. (2017). In this study they analyzed the survival game ‘This War of Mine’, which was developed and published by 11 bit studio. The game, inspired by the Siege of Sarajevo during the Bosnian War, differs from most war-themed video games by focusing on the civilian experience of war rather than on front-line combat. The authors discovered that in order to create a coherent game-world, it is important to conduct elaborate background research about the topic of the game, in this case war.

By the same token, an autobiography might be a new approach, which can be applied to a game so as to make the players understand and feel the same as another person whose life story and experiences are being related. Path Out is an example of an adventure game inspired by the autobiography of a young Syrian artist who escaped from civil war in his country (Meier 2017). This game is an ‘eye-opener’ for players to better understand the actions of a refugee. Abdullah Karam, the protagonist of Path Out, comments the game scenes himself as is common practice in YouTube videos, an element which adds to the immersion. Apart from being the main character in the game, Karam is also the game artist of Path Out.

3 Evaluation

Based on our initial motivation and findings from literature outlined above, our aim is to investigate how pro-social video games can influence the level of empathy. To this end we cover in the remainder of this section study outline, findings and discussion.

3.1 Study Design

Our research is focused on the influence of video games on the empathy level, more specifically the impact of playing neutral or pro-social video games on empathy skill development. This study addresses the following research questions:

- Can pro-social video game experience stimulate empathy? And how influences the number of interventions effects on empathy level?
- Is there a correlation between immersion and presence with empathy?

In order to answer the research questions above, we conducted two experiments toward four neutral or pro-social games getting involved a group of school and university student.

3.2 Setting and Instrument

Based on the literature survey outlined above, the study is based on existing work on four pro-social games: That Dragon Cancer, Path Out, Old Man’s Journey and This War of Mine. The target age groups varies from roughly teenagers till young adults and is accordingly considered in the study group formation.

Three standardized and validated self-report questionnaires are applied in the study for measuring perceives level of empathy, presence and immersion:

- **Interpersonal Reactivity Index Questionnaire (IRIQ)**

IRIQ measures four sub-dimensions of empathy based on seven items each:

- (1) Fantasy measures how strongly the player identifies with fictitious characters.
- (2) Perspective-taking dimension measures how strongly the player

adopts perspective or viewpoint. (3) Empathic concern looks into the degree of experiencing feelings for others. (4) Personal distress measures the feelings of discomfort and anxiety witnessing negative experiences of others. Each question of the IRI questionnaire (IRIQ) is multiple choice using a five-point Likert scale (Davis 1980).

– **Immersive Tendency Questionnaire (ITQ)**

The ITQ was created by Witmer & Singer in 1998. This questionnaire assesses immersive tendencies by the feeling of deep involvement in media and games usage. ITQ is a multiple choice questionnaire with a seven-point Likert scale (Witmer and Singer 1998).

– **Presence Questionnaire (PQ)**

The PQ assesses the sense of presence or subjective experience of being in a specific environment or one particular place (Witmer and Singer 1996). PQ is designed as multiple choice questionnaire with a seven-point Likert scale.

Following the overall goals of our research, the study is partitioned into two experiments, looking into different user groups and variations of the number of interventions.

Experiment 1. The aim of experiment 1 is to assess a short-term influence of playing neutral or pro-social video games towards the empathy skill.

Sixteen participants were classified into four groups depending on their age. Each group was then asked to play one of four video games, whereby the age rating of the game was matched with the given group age. The chosen games were ‘That Dragon Cancer’ for group 1 (10–13 years old), ‘Path Out’ for group 2 (14–16 years old), ‘Old Man’s Journey’ for group 3 (17–18 years old) and ‘This War of Mine’ for group 4 (over 18 years old).

First, each participant had to fill out the IRQ as a pre-test. In the next step, each participant was asked to play the game assigned to his group for one to two hours on his or her own. Once the participants finished the previous task, they were asked to redo the IRQ questionnaire as post-test. In the next step, we compared the pre-test against the post-test for each participant and analyzed the responses of the IRQ in order to measure the impact of playing those four video games.

Experiment 2. The second experiment focuses on multiple interventions and the influence on empathy experience in three selected games. Also, this experiment investigates the correlation of the perceived presence and immersion with the reported empathy experience.

In the first step, twenty-four selected participants were asked to fill out the IRQ as a pre-test. The participants were then divided randomly into three groups. Each group was asked to play one of three games, namely ‘Path Out’, ‘This war of Mine’ and ‘Old mans’ journey’. Subjects are asked to play the assigned games more than one time on his or her own. After the participants played the game multiple times on average some two hours, they were asked to

complete the post-test by filling in three standardized questionnaires: IRIQ, PQ and ITQ. In this experiment we selected only three games because participants have to fill out ITQ and PQ questionnaires, which are sufficient for players over 14 years old, while ‘That dragon cancer’ is relevance for 10–13 years old. Finally the data analysis has been performed with a main focus in influence empathy level and its correlation with presence and immersion level.

3.3 Study Participants

We recruited forty pupils and college students in Lampung Province, Indonesia, who are familiar with video games and spend an average time of 2.95 h per week playing video games. Participants are teenagers or young adults in the age range of 10–19 years. A demographic overview shown in Table 1.

Table 1. Demographic overview of students

Demographic aspects	Experiment 1	Experiment2
Age range	10 to 19	16 to 19
Age average in years	14.63	17.29
Standard deviations of age	2.16	0.95
Total participants	16 (100%)	24 (100%)
Female	7 (43.75%)	4 (16.67%)
Male	9 (56.25%)	20 (83.33%)
Number of interventions	Single	Multiple

3.4 Findings and Discussion

As for experiment 1, the reported level of empathy of 16 subjects from pre-test $M = 96.56$ ($SD = 13.47$) and post-test $M = 98.06$ ($SD = 13.18$) do not show notable improvements after one intervention with one of the four selected games (see also Table 2). More specifically, there were 9 (56.3%) who had shown an increasing IRIQ score on the post-test, 2 (12.5%) participants had the same score and 5 (31.2%) participants have a decreasing IRIQ score (see also Fig. 1).

As for experiment 2, the reported level on empathy after multiple interventions has increased slightly higher compared to experiment 1. Thus, the empathy level or 24 subjects has risen from pre-test $M = 94.54$ ($SD = 11.56$) to post-test $M = 98.17$ ($SD = 16.35$) after playing one of tree games multiple times (see also Table 2). More specifically, 14 (58.3%) subjects have shown a higher and 10 (41.7%) had a decreasing IRIQ score (see also Fig. 2). Findings also show a perceived level of presence of $M = 156.8$ ($SD = 13.4$) and immersion of $M = 128.8$ ($SD = 11.3$), individual level of the subjects are also illustrated in Fig. 3. Focusing further on the influence of perceived presence (PQ) and immersion (ITQ) on the empathy level playing one of the selected games, it can be reported that the highest level of correlation is between the perceived presence and immersion level with an correlation factor of 0.641.

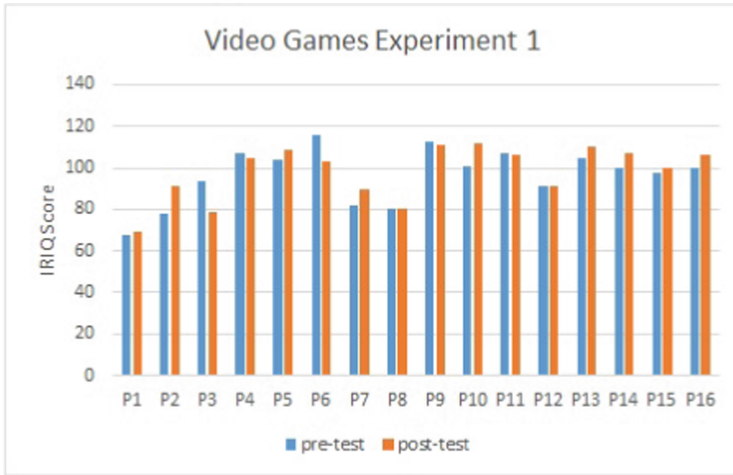


Fig. 1. Experiment 1: data analysis of four video games related to empathy based on a single intervention and 16 participants between 10 and 19 years old

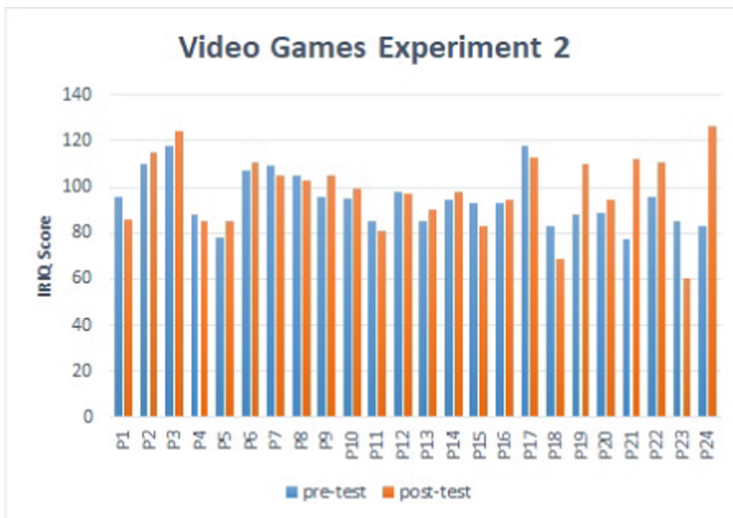


Fig. 2. Experiment 2: data analysis of three video games related to empathy based on multiple interventions and 24 participants between 16 and 19 years old

Such a correlation is expected as the perceived presence and immersion support each other. As for the correlation with reported empathy level after playing the game, findings reveal a higher correlation factor of 0.408 with immersion levels, compared to the lower correlation factor of 0.322 for the presence level. This indicates, that inducing a higher feeling of immersion supports may positively support a higher feeling of empathy.

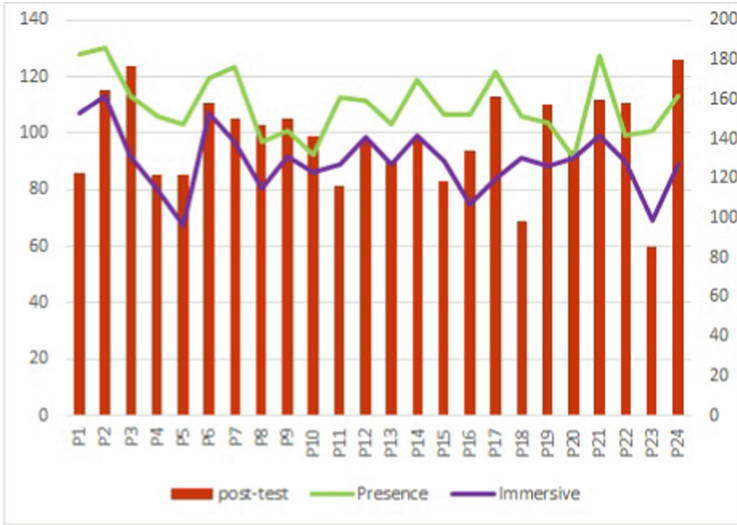


Fig. 3. Experiment 2: correlation between IRI, presence and immersive score

Finally, some qualitative findings from unstructured interviews of selected participants after playing one of the games are summarized. Subjects stated that the game they played did not have a significant impact on their empathy experience due to either an experienced short or unclear story-line. This might be mainly caused of the limited time and number of interventions. Also language barriers might have influenced the perceived experience. On the positive side, they liked basically the activity and paying a game on raising awareness on such aspects. Replies also revealed, that even the limited time, such games can support to change the player’s perspective and induce the player’s concern of character and the situation.

Table 2. Data analysis of video games experiments

IRIQ score	Experiment 1	Experiment2
Mean (pre-test)	96,56	94,54
Standard deviations	13,47	11,56
Mean (post-test)	98,06	98,17
Standard deviations	13,18	16,35

4 Conclusions and Future Work

Empathy is an essential skill, which is of growing importance in our modern and globalized society to solve intercultural conflicts and support international collaborations. Decreasing level of empathy caused by life style changes calls for new forms to experience and event train empathy. Video games in general can change and trigger emotions, pro-social video games in general are perceived to induce empathy.

This research has conducted initial studies on the effects of playing pro-social video games. Specifically the level of empathy and correlations with perceived presence and immersion has been investigated based on single and multiple interventions. Due to the limitations of small numbers of subjects in two experiments, engagement in pro-social video games can positively support the raise of the empathy level. Also a recognized positive correlation between perceived level of empathy and immersion provides room for further investigation on how game story, game type and game elements can support the feeling of empathy.

In future research, a more detailed study with a larger user group is planned, which looks specifically into gender aspects and the sub-dimensions of Interpersonal Reactivity Index Questionnaire (Davis 1980). Also variations of player behaviour and the perceived level of empathy is a subject of further investigations.

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