Player-Specific Conflict Handling Ontology

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Abstract

In this paper we propose a core, lightweight ontology around the axis of a serious game for adolescents. The Player-Specific Conflict Handling Ontology (PSCHO) that we propose provides a formal representation of the conflict in the domain of serious games. In particular, it maps visually manifested affective cues and emotional stimuli from the serious game to conflict handling styles, and suggests an appropriate educative intervention. Our final goal is to perform automated reasoning techniques over the PSCHO with the objective of leading the player to develop an integrative way of dealing with conflicts. With this approach, whenever a conflict event appears during the game, the appropriate educative intervention will be triggered according to both the reaction of the player at the time of the event and their general coping style. The importance of this ontology lies in the fact that it promotes natural interaction (non-invasive methods) and at the same time makes the game as player-specific as it can be for its educational goal. Finally, its core lightweight form allows for its further specializations in order to be adapted to other serious games as well.

Keywords: *serious game; ontology; conflict, emotion analysis*

1. Introduction

Concern about violence in schools has been increasing, and, correspondingly, conflict handling and resolution as well as peer mediation training programs have been proliferating [1]. Very popular tools in this process are Serious Games (whose primary purpose is other than pure entertainment). According to [2], the purpose of game-based learning/serious games is to leverage the power of computer games to captivate and engage end-users for a specific goal, such as to develop new knowledge and skills. A conflict handling game creates an artificial social environment in which the children are presented with different options when it comes to dealing with a conflict. It is very important to bear in mind that conflict is not necessarily bad. This point has been very effectively made by developmental psychologists working with children who have changing responses to conflict as they grow older [3]. The type of game indicated in the ontology described in this paper encourages an integrative way of dealing with a conflict (Section 2.1).

The digital game industry has lately realized an important shift towards Natural Interaction (NI). The keyboard and mouse are not necessary anymore non-verbal behavioral cues are the new – natural – means of interaction. Research work in the fields of psychology and cognitive science related to non-verbal behavior and communication point out the importance of qualitative, expressive characteristics of body motion, posture, gestures and general human action during an interactive session [4], [5]. In the system described in this paper affective analysis of the player is used to detect their emotional state during conflict. Conflict provokes different reactions from the participants according to their character and expressiveness ("To recognize that we are in conflict is to acknowledge that we have been triggered emotionally" [6]).

In the ontology presented in this paper visual information is used, providing important cues about conflict progress and possible subsequent reactions of the player. The relations between different concepts in the conflict handling and game playing domain, as well as the player's affective

behavior, are represented in the ontology in a multidisciplinary way. Researchers and developers in the fields of affective computing and conflict management/resolution can benefit from this, by getting access to relations and concepts from different sources.

Within the context of computer and information science, an ontology defines a set of representational primitives that model a domain of knowledge or discourse [7]. Thus, ontologies can capture a shared understanding of this domain and at the same time provide a formal and machine manipulable model for it. According to Oberle [8], ontologies can be classified according to purpose, specificity and expressiveness. In this context "purpose" ranges from application ontologies to reference ontologies (which are mostly used for terminological reasons). "Specificity" refers to foundational, core and domain ontologies, with the last being low on generality, and being more specific - and deeper - when describing a particular domain. The "expressiveness" of the ontologies distinguishes lightweight from heavyweight ones. Gruninger [9] describes the benefits of ontologies in three classes. The first class refers to their interoperability. Ontologies are both human readable and machine processable enabling communication between systems, between humans, and between humans and systems. The second class refers to their ability to enable computational inference (with automatic reasoning techniques implicit facts are derived to enhance traditional browsing and retrieval technology [10]). The third class refers to their reuse and organization of knowledge. Within this framework, ontologies are not only an efficient method for representing a domain, which in this case is the conflict handling game, but also a method for performing automated reasoning tasks to extract any required implicit knowledge.

In this paper we chose to develop a core, lightweight ontology around the axis of a serious game for adolescents so that we establish a set of clear axioms as a generic guide. The Player-Specific Conflict Handling Ontology (PSCHO) was created as part of the EU-funded project "Siren" [11] by the respective research and development team. The project's aim was to create a player-specific serious game that helps children of age 11-13 with conflict handling. The final goal was to lead the player of the Siren game towards the integrative way of dealing with conflict. In terms of representing the conflict domain, this ontology maps visually manifested affective cues and emotional stimuli from the serious game to conflict handling styles, and proposes interventions. As a result, it can be used as a guide by game developers to design and implement their own conflict management scenarios or design non-player characters that illustrate prototypical behavior and respond to specific events in the game environment. The ontology can also be extended to utilize information from additional player models or emerging information about the player (e.g. by questionnaires or interviews before playing the game) which can help define the player's status or conflict handling style before the game experience. Finally, in section 7 we test our ontology within the frame of the Siren project and we provide a test case where our approach is described in detail.

2. The Player

2.1 Conflict handling mode

In [12] the five modes of handling conflict are presented. These modes are described as: forcing, withdrawing, smoothing, compromising and problem solving. This scheme was reinterpreted in [13] by considering the intentions of a party in the following way: cooperativeness and assertiveness. The former describes attempts to satisfy the concerns of others, while the latter describes attempts to satisfy one's own concerns. The values of these dimensions combined describe the modes of behavior: competition, collaboration, compromise, avoidance and accommodation [14]. The competition mode suggests that one party places their interests before those of another party, and thus adheres to their own solution in solving the conflict. The collaboration mode suggests that solutions which are optimal for both parties are adopted. The compromise mode is employed when solutions that are acceptable for both parties are adopted. The avoidance mode occurs when a party displays passive behavior and shows no interest in conflict resolution. Finally, the accommodation mode occurs when one party allows the other to control the situation.

In [15] and [16] the styles are differentiated on two basic dimensions: concern for self and concern for others. The first dimension explains the degree (high or low) to which a person wants to satisfy the concerns of others [17] (Figure 1). For each of these styles, the interpretation in a game environment is mentioned.

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Dominating: high concern for self and low concern for others (win/lose).
Avoiding: low concern for self and others. Removing themselves from the conflict, resulting in no solution (lose/lose).
Obliging: low concern for self and high concern for others. Willing to let the other person have their way, giving in and giving up (lose/win).
Compromising: intermediate in concern for self and others. It may be appropriate when the goals of the conflicting parties are mutually exclusive (lose/lose).
Integrating: high concern for self and others. Awareness of both sides in a conflict, solving a conflict through working together. It is associated with problem solving which may lead to creative solutions (win/win).

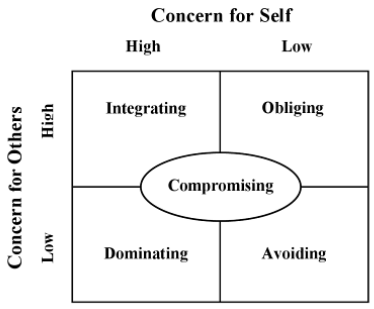

Figure 1. Conflict Handling Models by Rahim M. A. [17]

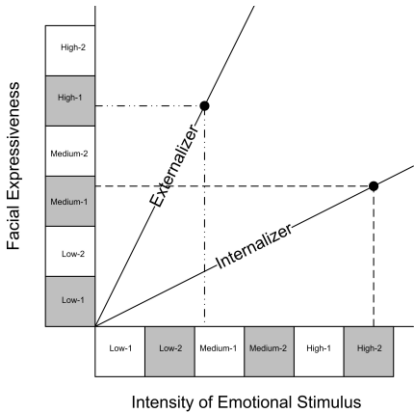

Figure 2. Theoretical correlation of facial expressiveness and emotional stimulus.

2.2 Conflict handling models: cultural aspects

The Face Negotiation Theory was proposed in [18] in order to understand how different cultures throughout the world respond to conflict. According to this theory, our self-image, or face, is at risk in conflict and our culture is attached to the way we deal with this issue and communicate. In [18] it is argued that in collectivist cultures, the face of the group is more important than any individual face in that group. In individualist cultures, the face of the individual is more important than the face of the group. People from collectivistic cultures usually adopt the avoiding or integrating conflict styles because the "mutual" face or the face of the group is the top concern. People from an individualistic culture adopt a dominating conflict style because their main concern is maintaining self face. This is due to the fact that they have a "face" that is independent from that of the group. The Face Negotiation Theory is proposed as a useful tool in order to expand the ontology analyzed in this paper. With further analysis, the theory could replace the conflict management questionnaire mentioned in Section 4, used to characterize the player, or enhance it.

2.3 Facial expressive response amplification – Internalizers and Externalizers

Internalization and externalization represent opposite poles on the trait-like dimension of coping style. Both coping styles may be used to reduce uncomfortable experience [19]. Internalizing

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individuals are typically characterized by low impulsivity, inhibition of feelings and overcontrol of impulses, whereas externalizers generally exhibit highly impulsive or exaggerated behaviors. It should be acknowledged, however, that some individuals' complex styles include coping behaviors characteristic of both internalizers and externalizers. For reasons of simplicity, the players' profiles whose coping style included characteristics of both internalizing and externalizing behavior were not taken into consideration for this specific study. According to [20] all strong emotions result in some degree of activation of the organism (i.e., principle of stimulus dynamism) but there are individual differences in the gain operating on the expressive and sympathetic facial response channels of individuals. Focusing on the facial expressive response, the individuals can be categorized as externalizers when their somatic nervous system is characterized by high gain and as internalizers when it is characterized by low gain.

3. Facial Expression

Psychologists have examined a broad set of emotions, but very few of the studies provide results which can be exploited in computer graphics and machine vision fields. Many studies ([21] - [25]) suggest that emotions can be represented in two or three dimensions and, regardless of the number of axes and the characteristics depicted on them, one axis always represents the activation (also defined as arousal, expressiveness etc). This is the characteristic we analyze in this ontology. We specify how "expressive" the player is (the quantity of facial movement they have) without defining the valence (positive or negative evaluation of the emotion). We could say that the player's emotional state is simply rated in terms of the associated activation level, i.e., the strength of the person's disposition to take some action rather than none.
Facial analysis includes a number of processing steps which attempt to detect or track the face and to locate characteristic facial regions on it such as eyes, mouth and nose. The following step is to extract and follow the movement of facial features, such as characteristic points in these regions, or model facial gestures using anatomic information about the face [26], [27]. Although the Facial Animation Parameters (FAPs) provide all the necessary elements for MPEG-4 compatible animation, we cannot use them for the analysis of expressions from video scenes, due to the absence of a clear quantitative definition framework. In order to measure FAPs in real image sequences, we have to define a mapping between them and the movement of specific Facial Definition Parameters (FDPs), i.e. Feature Points (FPs), which correspond to salient points on the human face. A detailed description of the analysis procedure can be found in [28]. The measurement of FAPs requires the availability of a frame where the player's expression is found to be neutral. This frame will be called the neutral frame and is manually selected or interactively provided to the system. For every facial feature (eyes, eyebrows, nose, mouth), a mask is extracted. The final feature masks are used to extract 19 FPs; FPs obtained from each frame are compared to FPs obtained from the neutral frame to estimate facial deformations and produce the FAPs. These deformations are used to define how expressive the player is, since large deformations characterize expressive players.

3.1 Facial expressiveness and emotional stimulus

Jones [29] was one of the first to use the term "internalizer" to refer to a person who has little expressive tendency but large and frequent sympathetic discharges (i.e. the stimulus is "felt" internally with great intensity). Respectively, he used the term "externalizer" to refer to a person who has high expressive tendency and infrequent and small sympathetic discharges (i.e. the stimulus "felt" internally has a smaller intensity). So according to this theory, the externalizing individual will experience the external stimulus with an intensity lower than the one experienced by the internalizing individual. Externalizers express themselves "abundantly" in an outward direction even though what they feel inside is quite moderate. For internalizers, a stimulus can have a great esoteric impact but a small proportion of this impact will be visible to the outside world. So, in normal circumstances, externalizers will not experience the highest levels of internal stimulus and internalizers will not fully express the intensity of what they feel inside. The facial expressiveness as a function of the intensity of an emotional stimulus felt by the individual is described for two individuals in [19] according to which there are individual differences in the gain (amplification) operating on the facial expressive response channels. As can be seen in the graph of Figure 2, which is based on [19], the function for the individual A who is characterized as an internalizer is different from the individual B who is considered to be an externalizer. In [21] both

axes of the graph have a qualitative scale in order to indicate relative differences. It can be seen from this graph that the point on the axis of facial expressiveness over which an intense emotional stimulus is revealed for an internalizer is lower than the equivalent threshold for an externalizer.

4. Psychological aspect of conflict styles

In this section we analyze the psychological aspect of the different conflict styles of an adolescent player.

- Dominating :

Adolescents who have a dominant conflict management style and have a tendency to turn into bullies in a school environment, are usually subjected to domestic violence [30] and the only way for them to "communicate" is by trying to exert their influence over their family members, i.e. they have a strong need to dominate others [31]. A person of that nature can have a difficult time moving away from such an individualistic mindset to a collective/cooperating one, because they have been habitually self-trained into having this behavior. Also studies have shown a relationship between the need for aggression and a dominating style of handling a conflict [32], [33], [34].

- Obliging :

The complete opposite of a dominating player, adolescent players who are obliging during a conflict could be so for a number of reasons: It's a non-confrontational style that may be used by an individual who prioritizes on preserving a relationship with another player (i.e. preserving a friendship with a classmate) over pursuing an outcome that only meets an individual's own concerns. On the other hand this style has been found to be used by an individual believing that he or she may be wrong and that the issue of the conflict in question is much more important to the other person involved [35]. Again, emotional attachment to a specific player can have an impact on the individual that chooses an obliging conflict management style, as well as low self-esteem.

- Avoiding:

The non-confrontational conflict management style of the player who avoids conflict is also labeled as inactive or withdrawing. This player has little concern for their own interests, or the interests of the player they have a conflict with. From research conducted on adults [36], which generally tend to use similar strategies with adolescents [37], a conflict-avoiding player behavior supposedly occurs because either the benefit in pursuing the conflict is small or because the other player/party to the conflict is unlikely to make satisfactory concessions. The person engaged in the conflict may hope that, if left alone, the conflict will somehow go away.

- Compromising:

The Compromising conflict management strategy typically involves "give and take" where both parties/players involved relinquish some aspect in order to arrive at a mutually acceptable decision [35]. It gives up more than the dominating style and less than the obliging, it is like a middle ground [38]. Compromise carries with it the assumption that both parties will be happy because each will gain something, but each loses something as well and this in turn creates the potential for further conflict. A player that handles conflict by compromising is not as efficient as an integrating player to solve a conflict because they have to give something up in order to get something, and there is a chance that the idea that they have to relinquish from could be the most efficient way to solve that conflict.

5. Conceptual Model

In this ontology the Facial Expressiveness of a player at the moment of a game event leading to conflict, as well as their Facial Expressive Response Amplification (Section 2.3), is used to determine the Intensity of the Emotional Stimulus felt by the player. Once this is accomplished, the Player's Conflict Mode (Section 2.1) is taken into consideration in order to present the appropriate Educative Intervention. The term "Educative Intervention" will be used throughout this paper as a term that involves several types of intervention – that can take the form of a transition to a different game environment, a pop-up window, the introduction of a Non-Player Character (NPC), the teacher's intervention etc - aiming to guide the player towards an integrative way of dealing with conflicts in a social environment. The Facial Expressiveness and Facial Expressive Response Amplification data is acquired from questionnaires that are given to the player prior to the game (examples can be found in [39], [40]). Thus, the player's Conflict Handling Mode will be

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characterized as dominating, avoiding, obliging, compromising or integrating whereas they will be characterized as an externalizer or internalizer in regard to their Facial Expressive Response Amplification. The Facial Expressiveness of the player is derived from the video recording of them playing the game while being faced with a game event leading to conflict. Such a game event generates a conflict of interests between two players and occurs when the actions of one person attempting to reach his or her goals prevent, block or interfere with the actions of another person attempting to reach his or her own goals [41]. The video is then processed by the facial analysis software in order to determine the levels of Facial Expressiveness.

Depending on whether the player is an externalizer or an internalizer the ontology describes the intensity of the facial expression according to the two graphs depicted in Figure 2. Using the graph mentioned above, the intensity of the emotional stimulus felt by the player can be determined (Figure 4). The user of this ontology can determine the threshold over which the intensity of the emotional stimulus is high enough to require the introduction of the Educative Intervention. In this paper the level "Medium–1" is considered to be this threshold. Note that, as described in Section 3.1, the threshold on the axis of facial expressiveness over which an intense emotional stimulus is revealed for an internalizer is lower than the equivalent threshold for an externalizer.

No action will be taken by the game in the following cases:

1. The emotional stimulus is below the threshold
2. The player's conflict mode is already Integrative

In all other cases the Educative Intervention will be implemented, aiming towards an integrative resolution of the upcoming conflict. The Intervention will be adapted to the player i.e. it will be dictated by the player's conflict mode (Figures 5, 6, 7). The type of Intervention (pop-up window, NPC, etc) will be determined by the ontology users.

The complete graph of the ontology can be seen in Figure 3.

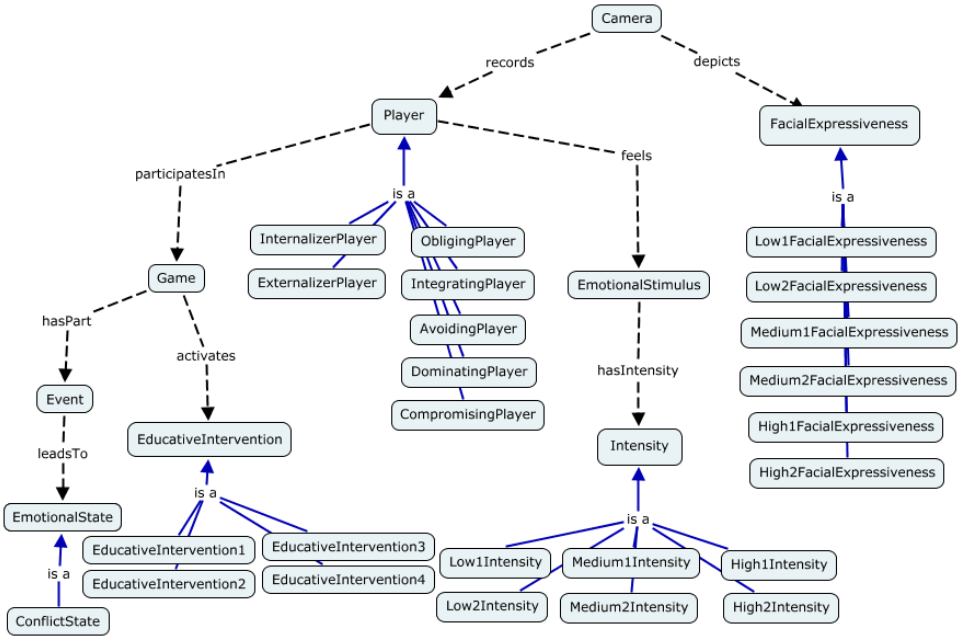

Figure 3. Complete graph of *Player Specific Conflict Handling Ontology*

Figure 4. Description of the concept Medium1Intensity of emotional stimulus (*section 6-The Ontology*)

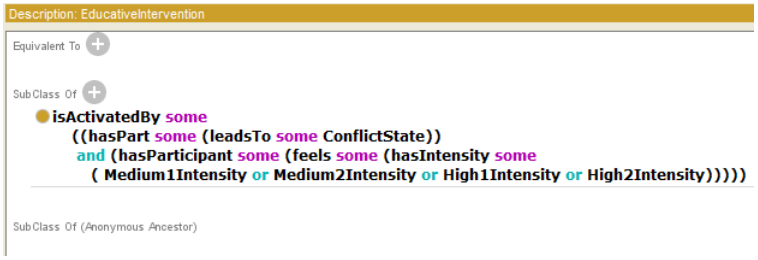

Figure 5. Description of the concept Educative Intervention (*section 6-The Ontology*)

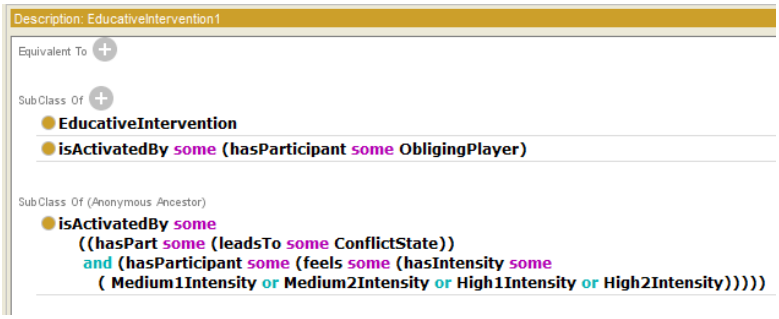

Figure 6. Description of the concept Educative Intervention1 (*section 6-The Ontology*)

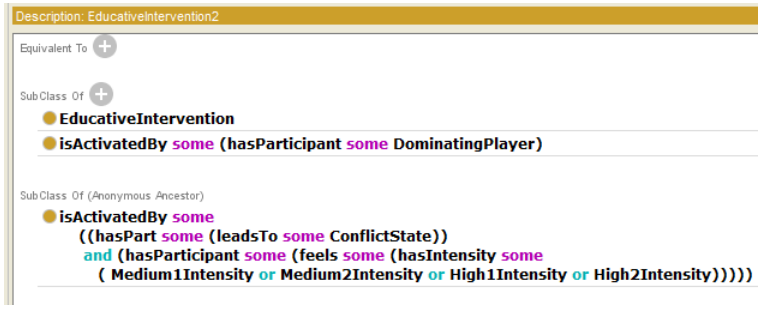

Figure 7. Description of the concept Educative Intervention2 (*section 6-The Ontology*)

6. The Ontology

In this work, the Player Specific Conflict Handling Ontology (PSCHO) is developed, based on the generic model described in the previous section along with the ontology engineering methodology –METHONTOLOGY– introduced in [42]. The objective is to develop an ontology flexible enough to be extended by future researchers for their purposes.

For the formalization of the conceptual model described in the previous section the Web Ontology Language (OWL) was adopted. OWL is a language for producing web ontologies of high expressivity while, at the same time, is machine readable and enables extension by third parties. The ontology PSCH was built using the free, open source ontology editor Protégé [43].

The first step is to build the glossary of terms from which we will derive the set of terms to be included in the ontology. Our glossary contains the concept Player which constitutes a core concept of the ontology. According to the player's conflict modes, and since we regard these modes as unique and permanent characteristics of each player, we introduce the concepts AvoidingPlayer, ObligingPlayer, etc. For the same reasons the concepts ExternalizerPlayer and InternalizerPlayer are also introduced. As the player participates in a game it is necessary to introduce the concept Game to represent any game played by a player. The concept Camera is also

used to represent the camera which records the player and depicts their Facial Expressiveness. The Facial Expressiveness and its levels as they are specified in Figure 2 are represented respectively with the concepts FacialExpressiveness, Low1FacialExpressiveness, Low2FacialExpressiveness etc. Also, during the game the player feels an emotional stimulus which has a specific grade of intensity. Hence, the concepts EmotionalStimulus, Intensity and its respective levels Low1Intensity, Low2Intensity etc, are required to describe the domain of interest. As was described in the previous section, the camera records the player while they are faced with a game event leading to conflict. Therefore, we assume that an Event which is part of a Game leads to an EmotionalState and at the same time a ConflictState is an EmotionalState. Finally the Educative Interventions are represented with the concept EducativeIntervention and, for the purposes of our ontology, are categorized in four types: EducativeIntervention1, EducativeIntervention2, EducativeIntervention3, EducativeIntervention4 (the number of types of Intervention is arbitrary here, it is to be determined by the user of the ontology).

According to METHONTOLOGY the second step in the ontology development is to build concept taxonomies to define the concept hierarchy. The hierarchy is depicted in the graph of the Figure 3 for brevity. The binary relationships between the concepts of the taxonomy are also depicted in the same graph. Although it could not be clearly depicted in the diagram, most of the relationships have a respective inverse one. For instance, the relation "activates" (domain: Game, range: EducativeIntervention) has an inverse relation defined as isActivatedBy whose domain is the EducativeIntervention and whose range is the Game. The set of relations between the concepts of the ontology are demonstrated in the Table 1.

Table 1. Binary Relation Table of PSCH Ontology

Relation	Domain	Range	Inverse Relation
Activates	Game	EducativeIntervention	isActivatedBy
Depicts	Camera	FacialExpressiveness	isDepictedBy
Feels	Player	EmotionalStimulus	isFeltBy
hasIntensity	EmotionalStimulus	Intensity	isIntensityOf
hasPart	Game	Event	isPartOf
hasParticipant	Game	Player	isParticipantOf
leadsTo	Event	EmotionalState	-
Records	Camera	Player	isRecordedBy

The ontology is completed with a set of terminological axioms that capture additional knowledge about the domain. In particular, new axioms are required to define the various levels of intensity of emotional stimulus: Low1Intensity, Low2Intensity etc, based on the plot of Figure 2. For instance, as it is demonstrated in Figure 4, the concept Medium1Intensity can be defined as: a) the intensityOf some emotional stimulus that isFeltBy some ExternalizerPlayer who is being recorded by some camera that depicts High1FacialExpressiveness, or b) the intensityOf some emotional stimulus that isFeltBy some InternalizerPlayer who is being recorded by some camera that depicts Low2FacialExpressiveness. Hence, if there is an internalizer or externalizer player for whom the camera records respectively Low-2 or High-1 Facial Expressiveness, then the intensity of the emotional stimulus will be defined as Medium-1. The rest of the levels of intensity are defined in a similar way.

For the purpose of our study it is also necessary to describe every Educative Intervention that appears in the ontology. As was described in the Conceptual Model section, when the intensity of the emotional stimulus exceeds a particular threshold an Educative Intervention is activated. In this ontology we assume that the threshold is any value that belongs to the range of Medium-1 intensity. Hence, we introduce a new axiom that describes the concept EducativeIntervention. This axiom is formally demonstrated in Figure 5 and expresses the fact that the EducativeIntervention isActivatedBy some game that hasPart an event that leadsTo some ConflictState and hasParticipant some player that feels some emotional stimulus that hasIntensity of: Medium1Intensity, Medium2Intensity, High1Intensity or High2Intensity. Each one of the four Educative Interventions

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inherits the aforementioned property of the concept "EducativeIntervention" and supposing that this property is being satisfied, then the appropriate Educative Intervention will be activated according to the conflict mode that describes the player. For instance, as it is shown in Figure 6, if the participant is an ObligingPlayer then EducativeIntervention1 is activated. Furthermore, as it is shown in Figure 7 if the participant is a DominatingPlayer then EducativeIntervention2 is activated.

7. Experimental Data

In this section we present the implementation of the Player-Specific Conflict Handling Ontology by the research and development team of the Siren project. The Siren project's aim was to create a player-specific serious game that helps children of age 11-13 with conflict handling.
The main game proposed by the Siren project is Village Voices. Village Voices is a multiplayer open world game that takes place in an imaginary village. On the surface, the game is about survival and prosperity in the village, but on closer inspection it is about friendship and reputation management in the village, and mastery of conflict resolution. When the game begins, each student-player is assigned a particular character to play, who is retained for the entire duration of the student-player's experience with Village Voices. As part of daily life in the village, players will be required to undertake various actions related to maintenance of their characters' livelihoods, and responsibilities within the village.
In keeping with the core conflict resolution concepts of mutual gain and collaboration, the objectives of the game shared by all players are to keep the village healthy and flourishing and to minimise negative aspects associated with life in the village, including a drop in quality of life.
Each player also has individual survival and prosperity objectives, which are measured in terms of the following meters: livelihood, health and wellbeing, reputation.
The central objective of Village Voices is for players to achieve guru status. This is attained once a player has experienced and resolved some subset of potential possible conflicts, demonstrated a nuanced understanding of different conflict perspectives, demonstrated the ability to creatively come up with suitable conflict resolution strategies in a range of different contexts within the village, and participated in counselling other players in terms of how to resolve conflicts in a constructive, positive manner.

At this point, the example of one of the players of the game will be presented and the implementation of each step of the ontology will be explained.
The player is given two questionnaires in order to determine their conflict management style and their degree of facial expressivity. The Conflict Management Styles Quiz determines a score for each conflict style. The one with the highest score indicates the most commonly used strategy. The Berkeley Expressivity Questionnaire scores one's expressivity from 1.3 (lowest degree of expressivity) to 6.6 (highest degree of expressivity).

The player's score at the Conflict Management Styles Quiz for every style was:
Collaborating/Integrating: 6
Competing/Dominating: 10
Avoiding: 5
Harmonizing/Obliging: 6
Compromising: 5
Thus the player is characterised as Dominating.

Concerning the Berkeley Expressivity Questionnaire the player's score was 2.2, which characterises them as an Internalizer. According to the Figure 2, where a full range of intensity levels for an emotional stimulus is represented, the threshold over which intervention will be needed for an internalizer player has been determined to be Medium-1.
Now the player is sitting in front of a laptop where they are going to play a SIREN game session on a LAN with 3 co-players. During the game session a camera records the player's face in order for the face-tracking software to detect the activation (Figure 9). The Y-axis units of the graph in Figure 2 is represented by the mean activation value that is computed by the parameters: "lEyeVerticalMetric", "rEyeVerticalMetric", "mouthVerticalMetric", "mouthHorizontalMetric", "lEyeInnerToLEybrowInnerMetric", "lEyeInnerToLEybrowOuterMetric", "rEyeInnerToREybrowInnerMetric", "rEyeInnerToREybrowOuterMetric" (Figure 10). In the case

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of this player, if a mean value of the Y-axis leads to an emotional stimulus degree higher than Medium-1, an intervention will be performed.
The Siren game keeps a "SirenSocialStanding" logfile that depicts the events the player is experiencing concerning their "social life" in the game.
At a certain point the player is faced with one of the events leading to conflict that have been mentioned in the previous paragraphs. This event is the refusal of trade by a co-player (Figure 8).

```
<LogItem><Timestamp>12 min 4 sec</Timestamp>
<SocialStandingOnePlayer xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
 <windowType>Single</windowType>
 <situationId>0</situationId>
 <playerAnsweringId>0</playerAnsweringId>
 <affectPlayerId>0</affectPlayerId>
 <senderPlayerName>Ξυλουργός</senderPlayerName>
 <unLocalizedSenderPlayerName>Carpenter</unLocalizedSenderPlayerName>
 <senderPlayerId>1</senderPlayerId>
 <itemType>ResourceORE</itemType>
 <itemAmount>0</itemAmount>
 <tradeResponse>decline</tradeResponse>
 <socialAction>Trade</socialAction>
 <valueForThisAction>1</valueForThisAction>
 <previousPlayerValue>0</previousPlayerValue>
 <rumourPositive>false</rumourPositive>
</SocialStandingOnePlayer>
</LogItem>
```

Figure 8. SirenSocialStanding logfile

At that point the face-tracking software detects a mean activation in the facial features of 24,24 units, which is an instance of the Medium1FacialExpressiveness class of the PSCH ontology. Hence according to the axiom:

High2Intensity ***is-a*** *(isIntensityOf some (isFeltBy some (InternalizerPlayer and (isBeingRecordedBy some (depicts some Medium1FacialExpressiveness)))))*

it is derived from the ontology that the stimulus has High2Intensity. Given now that the player is also "dominating" and according to the axiom:

Educative Intervention2 ***is-a*** *isActivatedBy some (hasParticipant some DominatingPlayer) and isActivatedBy some ((hasPart some (leadsTo some ConflictState)) and (hasParticipant some (feels some (hasIntensity some (Medium1Intensity or Medium2Intensity or High1Intensity or High2Intensity)))))*

it is easy to conclude that the Educative Intervention2 will be activated.

Hence, the supervisor of the player first asked the student to tell how they felt about the event and what their intentions were. As expected, the student said they would do the same to their co-player when the opportunity would come: they wouldn't accept the trade when next asked as a revenge. As mentioned in Section 4 this type of player's most important difficulty is the transition from an individualistic mindset to a collective/cooperating one. The supervisor used rational arguments to explain to them that the lack of cooperation and an aggressive attitude is something that can hurt them in the long run. The village in the game is a community whose prosperity depends on everyone and the gradual downfall of the community will eventually affect each one of the individuals. This was a good way to show a dominating style player the value of cooperative work, and that an egocentric, "head-on" approach isn't always the most appropriate solution to a problem.

7.1 Educative interventions for the SIREN game players

The educative intervention that would take place in the case of a dominating player has been described in the previous section. Here we briefly describe the interventions used for the other types of players.
As mentioned in Section 4 an obliging student is an individual who prioritizes on preserving a relationship with another player (i.e. preserving a friendship with a classmate) over pursuing an outcome that only meets their own concerns and has low self-esteem. A good way to remedy this was to split the players into groups with other players that are not real-life friends with each other, so that there was no emotional attachment with the other players during gameplay that encouraged

the obliging player to give in. A strategy we also used when possible was to put the player into a group of individuals that they felt somewhat competitive to. When the event leading to conflict would take place the supervisor of the game would remind the player why their role in the game is just as important as the other player's role, for the reason that each player has abilities that the other one has not (e.g. a woodcutter cannot do what a blacksmith can and vice-versa), and the game is most pleasurable when everyone works together, because the different abilities of each player, add to the game's diversity.

An avoiding player follows a non-confrontational strategy because they feel the benefit in pursuing the conflict is small (Section 4) so a good solution to this was to have the supervisor explain to the player that a conflict itself can be beneficial, and should not be avoided, because different perspectives on a conflict can generate new knowledge that would have never appeared otherwise. So there are benefits to be gained when each of the two conflicting players/parties tries to talk about their different points of view on the conflicting issue and reach a mutual agreement, instead of avoiding the conflict altogether.

The player that handles conflict by compromising always runs the risk of giving up on the conflict-solving idea that is the most efficient (Section 4). In order to deal with this problem the supervisor presented a problem to the player, in a form of a text-written story, with critical thinking questions being asked each time the storyline would reach a crucial point. The player wrote down their ideas and suggestions and had the supervisor of the game, evaluate their answers, examine the differences and choose the ideas that were most appropriate for the problem, and most acceptable by both parties. That way the player didn't get to be the one to choose the best solution, which could lead to a poor choice and more conflict, and was able to work together with the supervisor towards developing a creative solution that was accepted by most.

Figure 9. Face tracking system

```
0hrs::12mins::4secs::149millisecs::644microsecs::726nanosecs
(poseMetric: 0.281022
 gazeMetric: 10.9095
 distanceFromMonitorMetric: 1.04587
 lEyeVerticalMetric: 1.7774
 rEyeVerticalMetric: 1.15129
 mouthVerticalMetric: 35.5125
 mouthHorizontalMetric: 36.4985
 lEyeInnerToLEyebrowInnerMetric: 27.1796
 lEyeInnerToLEyebrowOuterMetric: 38.541
 rEyeInnerToREyebrowInnerMetric: 17.5015
 rEyeInnerToREyebrowOuterMetric: 35.7703)
```

Figure 10. Activation detected by the face – tracking software

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7.2 Limitations of the study

As mentioned above, this ontology was created as part of the EU-funded Siren project. As a consequence, the paper was focused on the specific serious game and in order for it to be adapted to other contexts there needs to be further research. Although the ontology, as described above, is fully adjusted to the requirements of the Siren game, it can be further specialized in order to be used by other serious games. Its core lightweight form allows for its users to implement the educative interventions they think are more appropriate and helpful according to the players, the environment in which the game is played and the game itself.

8. Conclusion – Future Work

In this paper we proposed a core lightweight ontology that provides a formal representation of the conflict in the domain of serious games. More specifically, it was developed, in order to enhance a serious game for conflict handling that implements player-adapted educative interventions. In our test case, automated reasoning techniques were performed, leading the player to develop an integrative way of dealing with conflicts.
Further adaptation can be done to the game's narrative, in order to present a more personalized player experience. Another aspect that can be investigated more deeply is multimodality - adding more inputs to the analysis software. These could be the player's voice or gestures, since the technology is already being used in commercial tools such as Microsoft Kinect, Nintendo Wii etc. Another input could be the biological signals which would add more accuracy to the detection of the stimulus' intensity. This is even more feasible at present, while maintaining the natural interaction aspect of the ontology as much as possible, since non intrusive, wireless EEG, HR, BP, SC sensors are widely available.

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