Chapter IX
Profiling Users in Educational Games

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ABSTRACT
For a long time, users’ emotions and behaviours have been considered to obstruct rather than to help the cognitive process. Educational systems have based their learning strategies almost solely at a cognitive level and the internal state of the learner has often been ignored. Even if it is now recognized that learners’ personalities and learning styles influence greatly their cognitive process (e.g. Multiple intelligences), very few systems have managed to profile users and adapt the educational content accordingly. Part of the reason for this is the difficulty to measure learning styles reliably and to establish a valid model that accounts for most of the major factors contributing to learning. Furthermore, since the introduction of formal education, it can be argued that learning has lost its playful and emotional aspect, whereby information was transmitted through story telling and play. On the other hand, video games have become a very popular medium among our digital natives. They provide a rich sensory and emotional environment in which they can experience a state of flow and are willing to stay for extended period of time. Despite of initial preconceptions on the negative effect of video games on young adults, it is now admitted that video games implicitly include many instructional design strategies (collaboration, exploration, Socratic dialogues, zone of proximal development, etc.) that could be harnessed to make formal education an experience that is more interactive and rewarding. One of the key features of video games is the ability to provide a content that matches players’ emotional needs (e.g. recognition, social bounding, self-esteem, etc.) and that provides a wide range of interaction. The authors believe that this potential can be harnessed to create an educational content that matches users’ learning styles.
and motivations. They propose the PLEASE model (Personality Learning styles, Emotions, Autonomy, Systematic Approach and Evaluation). This model addresses some of educational games design issues (e.g. choice of instructional strategy, type of feedback required, etc.); it categorizes and profiles users’ learning styles in the light of educational and personality theories and defines a set of practical strategies for educational games designers in order to match students’ learning styles and provide a user-centred content that is both motivating and educational. The authors explain how the Big-5 can be a more reliable alternative to measure learning styles, how emotions and personalities can be accounted in the cognitive process (e.g. information retrieval, memory retention, etc.) and also describe experiments they carried out in Cork to assess the effect of user-centred approaches in educational game design. Results are analysed and contrasted with current practices to show that unless personalities are accounted for in educational games, the educational outcomes could be different or even opposite to the one expected.

INTRODUCTION

In this chapter, the authors will describe the work they have carried out to assess the potential of educational video games to teach Mathematics to secondary school students. They describe the PLEASE model, a model that encompasses instructional design, educational psychology and game design theories to improve the design of more engaging and effective educational games.

THE PLEASE MODEL

History and Rationale

Since the 1970s, a new generation of students have emerged. They use digital devices extensively, and more importantly, they are avid video gamers. Computer games have had a profound impact on the way the vast majority of young people process information. They include many features that are not yet acknowledged or used in school settings but that might facilitate the learning experience. Video games represent real learning environments where learning occurs naturally to overcome challenges posed by the game play. In this context, video games can be compared to a language that supersedes current languages. Using video games, young students can express themselves, communicate ideas, and collaborate with other peers. Using such a medium for teaching can prove effective to both motivate and illustrate effectively concepts and ideas to this young generation of students. While the military and some companies have embraced the use of video gaming technology to train new recruits, the move in the academic sphere has been slower, even if software such as Second-Life is progressively assessed and recognised as a valuable asset for collaborative and exploratory learning.

Video games can be compared to micro-worlds offering a wide range of opportunities for learning and adapting to each individual’s learning style and preferences. Their rich interactive environment makes it possible for individuals to learn in a way that suits their abilities. Collaborating, reflecting, interacting with the content are some of the many possible ways to learn in these environments. However, despite a promising educational potential, video games designers still need to find means to adapt dynamically the content and the structure of the game depending on students’ profiles. User profiling is a growing research field that aims to categorise the players and find ways to predict their actions, preferences or needs.

Developing educational games that adapt dynamically to users’ cognitive and emotional
state represents an interesting challenge for developers and educators. The authors will describe their approach to designing dynamic educational games through the PLEASE model (Personality Learning styles Emotions Autonomy Systematic approach and Evaluation). This model, inspired by observations of students’ behaviours, accounts for users’ differences at cognitive and emotional levels and offers a solution based on game design techniques to maximize learning strategies and outcomes. The following sections will explain the rationale for this model, its theoretical foundation and experiments carried-out to assess its validity.

BACKGROUND

Since March 2005 the authors have been involved in a project to evaluate the educational benefits of video games for teaching mathematics and sciences in secondary schools. This project involves teachers and students of two Cork secondary schools and seeks to help students to improve their skills and motivation for scientific topics through rich interactive experiences. Overall, it aims to address the issue of the shortage of science students at college level. By increasing their interest and proficiency in sciences, the hope is that they will embrace a scientific career after their leaving certificate. This project was initiated by a discussion with a school liaison officer in University College of Cork who had identified a need for more interest in scientific careers. This view was confirmed during further interviews with teachers. They expressed their concerns about students’ lack of enthusiasm for scientific topics and the need to introduce tools and methodologies that could improve both their motivation and academic results. Subsequent meetings were conducted to identify areas of the curriculum that might benefit from a Game Based Learning (GBL) approach and several issues with existing tools were identified:

- Available software packages were often not based on the curriculum and failed to support teachers’ classes.
- Training material often failed to engage and motivate students.
- Time available to use these tools was often limited making some of the tools unusable.

It was decided that a video game would be developed to support the teaching of algebra skills. To determine the format and structure of the game, it was decided that a survey would be conducted to evaluate pupils’ preferences for particular types of games, their level of familiarity and proficiency at playing games. The questionnaire was designed and implemented through web technologies (PHP) to facilitate the collection and analysis of answers. It included a total of 19 questions in three different sections: game preferences, game qualities and personal information (e.g. gender, age, etc.). It included a combination of closed and open-ended questions. The questionnaire started with a brief introduction on its purpose, the topics covered and how the results would be used. 41 pupils aged between 13 and 14 (2nd and 3rd year) took part in the survey. Analysis of the responses showed that the majority of the pupils played video games (56%). They often preferred role-playing games and played regularly (once a week for 29.7% of the respondents). Interestingly, only 20% of the respondents had played an educational game previously and very few of them (20%) enjoyed them.

The game was named MathQuest and was designed to accommodate pupils with no frequent or prior experience of video games and to be played on a number of different platforms. Java3D was chosen as a programming language for this game as it allowed for platform independence as well as relatively fast 3D content creation. It featured a 3D-maze in which players had to navigate and find the exit to the next level in less than twelve minutes. Each level included a set of doors that
players had to open to progress further in the game. To open a door, players had to solve a linear equation, which consisted of five steps. The following screenshots shows the sequence of events encountered by players.

When the game is loaded, players can click on the green button to see the instructions (see Figure 1).

Instructions are provided to players on their objectives and controls (see Figure 2).

Players need to navigate through the maze. They have access to a map (top left corner) that can be hidden if necessary.

- Green square: symbolizes the exit.
- Blue Square: symbolizes a door.
- Red Square: the players’ location
- Time is also displayed (top left corner) (see Figure 3)

When users are near a door, they are asked to solve an equation (see Figure 4).

After solving equations and finding the exit, players can access the next level. A map of the maze is also available; it shows the location of the user but also doors and the exit of the current level (see Figure 5).

The video game was developed using an incremental process whereby students and teachers were actively involved in the design of the game to make sure it was usable, educational and fun to play. An iterative approach was used and feedback was noted and implemented in subsequent versions.

The game included a tutoring system able to track users’ knowledge and misconceptions and
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Figure 5. Second level

...to trigger appropriate corrective actions. The core of the tutoring system includes four separate modules: expert model, pedagogical model, student model and interface model.

- The expert model included knowledge to be gained by users on solving equations.
- The pedagogical model included strategies to apply to teach the required skills.
- The student model included information on the user such as: proficiency for a particular skill, common mistakes, time to complete equations and levels, etc.
- The interface model included different modes of representation of the information to the user. The software was also available as a text-only version (for testing purposes).

Using a controlled study, the educational effectiveness of the software was assessed. The experiments included two groups of students. Both groups had to take a written pre-test and post-test. The tests were divided into two sections. In the first section, students had to solve five equations and specify for each of them the steps followed to obtain the result. In the second section, students had to answer five additional questions. For these questions, they were asked to specify using an MCQ (Multiple Choice Question) which next step they would take to solve a particular equation. An example of questions in this section would be: “If you had to solve $2x-2+2=4-2$ what would you do?”. Teachers had previously assessed each test. In the first section of the test, marks were awarded to students based on the results, accuracy and the level of detail of their answers (steps described). In the second section marks were awarded based on the answer selected. The two groups took the pre-test and post-test at the same time. They also played the video game at the same time and in the same room. The students were randomly assigned to the control group (A) and experimental group (group B). Students who belonged to groups A and B played two different version of the game. In the first version (group A), the game did not include any educational content and students were told that the game was designed to improve their spatial skills. In this version of the game, students needed to navigate through a maze, find and collect at least five boxes and reach the exit of the current level. The second version of the game included educational content and was designed to improve students’ mathematical skills by requiring them to solve equations as a condition to progress further in the game. In this version, students needed to navigate through a maze, open doors and reach the exit to the next level. However, in order to open a door, it was required that students solved an equation. Throughout the solving process, a tutoring system would help students, analyse their mistakes and misconceptions and provide dynamic feedback.

Initially, it had been planned that the control group would not play the game. However, teachers advised that all students played the game (in different versions) for none of them to feel left out.

Table 1 shows the difference between the pre and post-tests for both control and experimental groups.

Table 1 shows that the average marks for students who played the educational game have improved more than for those who played the placebo. It confirms that the game can bring noticeable improvements to the understanding...
of the process involved in solving equations and can therefore be effective to teach topics that could otherwise seem uninteresting. This study also provided an insight into the different ways in which the students benefited from the software. Several patterns, identified by teachers and the designers, suggested that behaviours and the emotional state of the pupils could have a significant impact on the way they could learn through the video game. Whereas some pupils were shy, introverted and nervous when playing the video game, some other pupils displayed more extraverted and confident behaviours and seemed to outperform their classmates. Some other students, when asked to solve an equation, entered random solutions until it worked.

Table 1 shows that the two groups did not have similar average marks for the pre-test and suggested that the group B was generally initially more proficient at solving equations than group A. A discussion with teachers after the pilot group confirmed this assumption. They had assumed that the game would be more beneficial to pupils with lower skills and therefore decided that these
pupils would be allocated to group B. The results suggest that their assumption was partially correct in that the game would be highly beneficial for pupils who had great difficulties understanding the process of solving equations. It is believed that a slight confusion occurred between the groups A and B during experiments, which corrupted some of the results and their statistical analysis. It is possible that some of the pupils who belonged to the group B took part in the experiment as if they were part of the group A, hence lowering the percentage of improvement for the control group (-0.14%).

Following this study, it was decided that further research would be conducted in order to discover links between personality, emotions and learning in video games. The hope was that by understanding the interaction between pupils and the educational software at both cognitive and emotional levels, it would be possible to provide an environment that suits their preferences and emotional response and hence improve the learning outcomes.

THE IMPORTANCE OF PERSONALIZING SYSTEMS FOR IMPROVED LEARNING

About Personality and Learning

In 1983, Gardner introduced the principle of multiple intelligences, which implied that individuals possess natural predispositions to understand specific topics and to process information. This is often referred to as learning or cognitive styles.

It is expected that, when students are taught in an environment that matches their learning style, relevance, interest in the topic taught and motivation can be increased (Lambert et al., 2002) and, as a result, educational outcomes can be improved (Levine, 1999; Green et al., 2006, Lambert et al., 2002). Learning styles have three essential aspects: cognitive (perceiving thinking, problem-solving and remembering), physiological (e.g. gender, nutrition, health and reactions to physical environment) and affective (e.g. personality, motivation, peer interaction, etc.) (Reef, 1992; Keefe, 1988). Whereas formal education has been focusing on cognitive aspects of learning styles, it can be argued that more emphasis should be put on the emotional aspect of learning.

The difference between individuals’ learning styles has been widely recognised among educational practitioners and educators. However, very few educational software packages have harnessed this potential despite increasingly personalized and rich interactive day-to-day applications. Part of the reason for this could be that it is very difficult to measure factors that influence learning; these factors can be multiple and complex (cultural background, behaviour, environment, etc.). Another issue is that learning styles can evolve over time; as a result, their measurement might be unreliable (Brown et al., 2006). Also, tools to measure these learning styles might lack validity and methodologies used to gather data might not always account for potential bias such as placebo effect, as suggested by Coffield et al. (2004).

Whereas the measurement of learning styles can prove difficult and unreliable, more reliable and accurate tools have been developed to assess...
personality traits. While the study of personality cannot explain all the differences in learning styles, it is accepted that there are correlations between learning styles and personality traits and that it is possible to explain some information seeking strategies by analysing individuals’ personality types or traits (Child, 2004; Honey and Mumford, 1982; Riding and Wigley 1997).

For example, personality traits such as Neuroticism (e.g. prone to anxiety) can have a profound negative impact on working memory (Eysenck 1992; Calvo and Eysenck 1996; Elliman et al. 1997; Hopko and Gute 1998). Conversely, if anxiety can be reduced then learning performance can be improved.

Learning styles represent a subset of personality characteristics (Jackson and Lawty-Jones, 1996) and hence can be measured through personality tests (Furnham, 1992). For example, the NEO-PI (Costa & McCrae, 1985, 1992) was proved to be correlated to the Eysenck Personality inventory (Eysenck and Eysenck, 1964) and to other thinking style variables such as creativity and divergent thinking (McCrae, 1987) and achievement motivation (Busato et al., 1999). Likewise, Zhang (2006) has identified that thinking style can vary according to personal characteristics, that teachers’ thinking style is influenced by their teaching experience and that their evaluation of a student’s work can also be influenced by the student’s learning style. Their results show that Neuroticism could explain 41% of the variance in thinking styles whereas extraversion had the least influence explaining only 29% of the variance.

**About Personality Traits and Styles**

The field of personality study analyses common characteristics and behaviours across humans; it helps predict emotional response and behaviours in particular situations. This field is quite mature and tools to measure personality type or traits have been developed and recognized to be both valid and reliable. Furthermore, studies grounded in educational psychology have determined correlations between students’ personalities, their preferences for learning content and interactions between teachers’ and students’ personality types. The advantage of such an approach to determine and assess learning style is that personality types are relatively stable over a long period of time.

Personalities can be analysed and described in terms of personality traits or personality types. For the former, an individual belongs to only one of several pre-defined categories whereas, for the latter, individuals’ personalities can be described in a 5-dimensional space. Personality types and personality traits can be respectively measured through the MBTI (Myers-Briggs Type Indicator) and the Big-5 model. These are two widely recognized personality models among psychologists that allow for a reliable and valid assessment of personalities.

The MBTI model was developed by Myers and Briggs (1980). It indicates peoples’ preferences for a particular type of interaction or way of thinking rather than an ability and makes it possible to measure personality types. Not only does this model provide a solid basis for the prediction of human behaviour but studies also show that the categories it comprises can be correlated to learning preferences and information seeking strategies in information systems. Categories of this model include: Extraversion-Introversion (E-I), Sensing-Intuition (S-N), Thinking-Feeling (T-F) and Judgment-Perception (J-P). Each of the 16 personality types present in the MBTI is a combination of four mutually exclusive dichotomies (E-I, S-N, T-F and J-P). For each dichotomy, individuals do not have levels but instead a preference for one of its components (e.g. either Extraversion or Introversion, Sensing or Intuitive, etc).

The big-five model was initially introduced by Thurnstone (1934) and Norman (1963) and then further refined by McCrae and Costa with the NEO-PI (1985). It uses five dimensions to measure people’s personality: Openness (eager to learn and open to new experiences), Consci-
entiousness (hard worker), Extraversion (enjoys social interaction), Agreeableness and Neuroticism (prone to stress). In this model, individuals can have a combination of different levels (low or high) for each personality trait. The IPIP (International Personality Item Pool), a methodology based on the Big-five model, was created to measure personality traits through a set of 50 questions. Results show that the IPIP is reliable, valid and that it allows for an easy computerisation of the results.

There are correlations between the two models (McCrae and Costa, 1989; Furnham, 1996). E-I, S-N, T-F and J-P are respectively correlated to Extraversion ($\alpha = -0.74$), Openness ($\alpha = 0.72$), Agreeableness ($\alpha = 0.44$) and Conscientiousness ($\alpha = -0.49$). This makes it possible to extend some of the educational findings based on the MBTI to the big-five model and vice-versa.

**Using Video Games to Provide New Means to Adapt to Learning Styles**

Throughout the evolution of educational technology, the design of instructional software and tutoring systems has been significantly influenced by educational theories. Whereas CAI (Computer Assisted Instruction) was essentially based on behaviorist theories, subsequent versions applied cognitivist theories in an attempt to model and predict subject’s cognitive processes. More recently, the emergence of 3D virtual learning environments has made it possible for students to learn by doing. This constructivist approach to learning is an opportunity for students who enjoy interacting with objects and other participants as part of the learning process. Recent systems such as Sloodle encompass both benefits of tutoring systems and virtual reality. In these settings, users can achieve learning outcomes in many different ways. They can interact with their peers, use rich interactive content and interact with objects to further their understanding of a particular topic. For this reason, video games seem to be more suitable that traditional school settings to adapt to students’ preferences for learning.

**THE ROLE OF EMOTIONS IN LEARNING AND VIDEO GAMES**

**The role of Emotions and Emotional Intelligence in Education**

Emotions are strongly related to motivation (Schilling, 1996) and they both play a major role in learning (Maslow, 1968). Educational content devoid of emotions makes the educational experience less vivid for students and also makes it more difficult to apply educational experiences to real world situations (Shilling, 1996). However, emotions have for long time been ignored in the educational system (Silberman, 1970; Neil, 1960). According to Astleitner & Hermann (2000), positive and negative emotions should be accounted for to accommodate and promote learning. It is advised that, to support learning activities, negative emotions such as fear or anger should be avoided, and that positive emotions such as sympathy and pleasure should be promoted. However, the polarity of emotions (positive or negative) can have both a positive or negative impact on the learning activities depending on the task in hand and on the learner’s personality (Salovey et al., 2000). For example, positive emotions are associated with an open approach and creativity whereas negative emotions might trigger more focused and deliberate strategies. Furthermore, positive emotions impact more significantly on memory (Singer & Salovey, 1988) and the cognitive process (Stege et al., 1994).

The way individuals encode or recall information is usually influenced not only by the emotions of the learner at encoding but also by the emotional content or tone of the material to be learnt (Parott and Spackman, 2000). Any information to be understood and memorized is analysed in the working memory, which controls
and integrates visual, spatial and verbal information (Riding, 2002). However, working memory differs across individuals (DaneMan and Carpenter, 1980) and can be influenced by emotions such as anxiety (neuroticism-stability). It is agreed that meaningful learning occurs when the new material is compared to existing knowledge and then incorporated and organised in the long-term memory according to students’ cognitive styles. Therefore, positive emotions, curiosity and passion drive students toward their goals.

Perceiving and managing emotions can also have a profound impact on learning activities and it is suggested that emotions can help to promote self-awareness, decision-making and stress-management (Schilling, 1996). Emotional Intelligence has been outlined and shown to be in accordance with Gardner’s theories on intrapersonal and interpersonal skills (Salovey et al., 1990) which consists in knowing ones emotions, managing emotions, motivating oneself, recognizing emotions in others and handling relationships. Emotions and Emotional Intelligence progress and mature through childhood. For example, research has shown that some emotions such as shyness or boldness are genetically encoded but can however be improved with some experience (Schilling, 1996). Emotional Intelligence allows subjects to acquire and apply emotionally charged information. It has an impact on both learning and behaviours and it is agreed that Emotionally Intelligent pupils usually perform better and are less disruptive than their peers. Furthermore, it is suggested that IQ scores only account for 20% of success in challenges faced in daily life and that the remaining 80% can be predicted using Emotional Intelligence (Goleman, 1995). The reason for this is that IQ measures only cognitive skills but not emotions, which are in fact responsible for motivation, which to a certain extent affects the desire to learn and to achieve (Schilling, 1996).

According to their personality dominant traits, individuals can be more inclined to feel particular emotions. For example, people with a high level of Neuroticism are inclined to feel negative emotions. Extraverts will be more inclined to feel positive emotions but they also will feel more intensely the excitement of a reward, which to some extent makes positive reinforcement an appropriate technique to improve learning (Depue and Collins, 1999).

**Emotions in Educational Games and Intelligent Tutoring Systems**

Video games allow players to feel a wide range of emotions (Lazzaro, 2004; Freeman, 2003) and to role-play through characters. By feeling and empathizing, children can develop their emotional intelligence and indirectly become better at learning, be more motivated and focused. In addition, role-playing can also increase emotional awareness; because role-play makes them aware of the feelings that one might experience in specific situations (e.g. bullying). As suggested by Shilling (1996) “The brightest future belongs to students who develop EQ along with IQ” and video games might well help the development of emotional skills.

There is a link between emotions, game play and interactions in video games. Emotions can be induced by game play variables and can influence players’ behaviour and hence their interaction with the game. This interaction, if the game is of an open-ended nature, will in turn influence the game play. Conversely, changes in the system can be attributed to specific emotions. However, it is still difficult to measure emotions based on players’ behaviours in video games. Some studies have correlated players’ actions to the level of arousal of the player (e.g. pressure on the gamepad buttons; Sykes and Brown, 2003) however valence cannot always be measured accurately. Studies have managed to infer users’ emotions based on their behaviour or to create virtual characters that show emotions. For example, Chaffar et al. (2005) have developed a system based on Gagne’s...
instructional conditions for learning. It induces emotions in users to support them through different learning stages (attention, acquisition, retrieval and response organisation).

Since emotions can play such an important role in memory retention and on the cognitive process, it is expected that designers should be able to influence how players learn in educational games using Mood Induction Procedures (MIP). For example, music can have a profound relaxing effect on subjects (Salamon et al., 2002) or conversely negative physical effects such as cardiovascular alterations, cardiac arrhythmias. When pleasant music is heard, positive memories and feelings can be experienced. Similarly, MIPs are designed to induce a specific feeling in a subject and can be achieved through a wide range of techniques including: self-statement, music, autobiographical recall or films (Banos et al., 2003). Some of these techniques (e.g. music, autobiographical recall, solitary recall and movies) can induce the required mood in 75% of cases, whereas other techniques such as Velten, social recall, facial expression and social feedback only achieve 50% (Velten, 1968; Gerrards-Hessert et al., 1994; Westermann et al., 1996). Some other methodologies based on the use of symbols and dialogues have been developed to create emotions in games (Freeman, 2003) and originate from the film industry.

### USING LEARNING STYLES AND EMOTIONS IN GAMES: THE PLEASE MODEL

#### Rationale for the Model

The previous section has emphasised the benefits of considering pupils’ emotions, personality type and learning styles to improve the effectiveness of educational games. It has illustrated how adaptive settings based on the users’ internal state might improve both the cognitive process and motivation. Based on these observations, Felicia & Pitt (2007) have created the PLEASE (Personality Learning styles Emotions Autonomy Systematic approach and Evaluation) which addresses common issues faced by designers and educators. Through this model, the authors provide guidelines and a systematic approach for educational game designers. It accounts for and analyses students’ preferences, teachers’ needs and environmental constraints. It also addresses learning at both cognitive and emotional levels but essentially focuses on a user-centred approach, whereby strategies are defined to accommodate students’ personality and internal state.

### Strategies Based on Personalities

Based on educational psychology theories, the authors have identified potential strategies to improve challenge and learning in educational games. They have identified five influential features for educational games: information type (true, false or misleading), information structure (e.g. linear), information presentation (e.g. audio, video, text, etc.), game structure (linear or open-ended) and type of learning activity (repetition drills, exploration, etc.). Based on the big-five model and related studies identifying information/learning preferences (Briggs-Myers et al., 1985; Keirsey, 1998; Heinström, 2003), they established a model that specifies possible preferences in educational games based on personality traits.

#### Learning Styles and Information Seeking Strategies

Heinström (2003) carried out experiments aimed to evaluate how, based on their personality traits, subjects sought information in a computerized system. The study, based on the big-5 personality model, highlighted several patterns. It concluded that individual patterns of information seeking should be accounted for and that personality ought to influence information seeking-strategies. The study suggested that subjects with a
low level of Conscientiousness (careless subjects) might have a more impulsive and disorganised approach to learning whereas subjects with a high level of Conscientiousness will be more structured and methodical. Information seeking behaviours measured in this study included: time pressure as a barrier to information, confirmation of previous knowledge, critical information judgement, willingness to acquire new ideas from retrieved information and effort. The study showed that careless, competitive, sensitive and conservative subjects found it difficult to know if the information was relevant. Easy going, introverted, sensitive and competitive subjects experienced time pressure. Introverted, conservative and conscientious subjects preferred to retrieve information that confirmed their previous knowledge. Outgoing, open and conscientious subjects enjoyed acquiring new ideas. Moreover, extraverted subjects usually found information through informal sources like teachers and friends. The study concluded that subjects with high levels of Neuroticism were vulnerable to negative emotions, preferred confirming information and felt that lack of time was a barrier. Subjects with high levels of Extraversion preferred thought-provoking content. Subjects with high levels of Openness were prone to incidental information acquisition, critical information judgement, and enjoyed though provoking content.

Personalised Strategies for Educational Game Design

Customizing the Type of Information Provided
Throughout video games, aural, visual or textual information is provided to users; they can be accurate, misleading, partial and false (Alessi and Trollip, 2001; Teem, 2001). This information can have different effects on players depending on their personality. Whereas misleading or partial information might increase challenge and motivation for users with a high level of Openness or Competitiveness, accurate information that confirms previous knowledge might be preferred for students with a high level of Neuroticism. In addition to the content of the information, the media used can also be tailored to students’ learning styles.

Customizing the Format of Information Provided
Feedback in video games is essential so that students can reflect upon their action and perform corrective actions. Whereas time information might have a negative impact on students with a high level of Neuroticism, ranking information might be beneficial to students with a high level of Competitiveness as they strive to outperform their peers. In addition, feedback can also include emotional content. Whereas motivating or challenging sentences might be used for students...
with a high low level of Neuroticism, reassuring sentences might be preferred for students with a high level of Neuroticism.

**Learning by Doing or Using Booklets**

Whereas players generally prefer to learn about a game by playing, booklets might prove useful for students with a high level of Neuroticism, Conservatism and Introversion because they enjoy written material and feel more confident using a medium or information that confirms or relates to information they already know. Demo levels where players can experiment with the game mechanics might be especially suited to students with a high level of Openness because they can enjoy exploring and experimenting without being penalised for incorrect moves or actions.

**Linear vs. Open-Ended Game Play**

According to Aldrich (2001), game-play can be of at least three types: linear, cyclical (drill and practice) and open-ended. Linear content might be especially suitable for users with a low level of Openness because they like clear objectives and structured material. On the other hand, open-ended content might appeal more to users with a high level of Openness who show a high degree of creativity and enjoy exploration. Cyclical information might be especially suitable for students with a high level of Neuroticism but might have the opposite effect for student with a high level of Openness who can see the bigger picture and might find repetition boring. Discovery learning might be used instead.

**Using NPC Behaviours and Dialogues**

NPCs in video games can be used to increase the emotional impact on players and also provide alternatives to find information by engaging in dialogues. Students with high level of Agreeableness who are prone to empathise with specific situations might appreciate dialogues with NPCs which use emotions that might touch the player.

**Using Books and Videos**

Video games often include items that can be found by players. Books or any written material might be suitable for players with a high level of Introversion.

**Strategies Based on Emotional Response**

The Neuroticism trait present in the big-five model often measures an emotional dimension for individuals and it is recognised that subjects with a low level of Neuroticism will have a relatively stable mood, which would allow mood dependent and mood independent techniques to be used efficiently. The authors suggest that positive moods could be used to:

- Facilitate the cognitive process,
- Facilitate creativity,
- Reassure subjects prone to stress,
- Create dialogues that engage players’ emotions (e.g. empathy, pride, etc.).

These moods can be induced using music, especially with subjects with a low level of Neuroticism (Salamon et al., 2003; Banos et al, 2003). Therefore, the aural dimension of the game should be considered at the initial stage of the design of educational game. If the music is not synchronized to the game play, players can be distracted and their gaming “experience” affected. Sounds affect the users’ mood and should be given as much importance as colours or graphics. Game designers and sound engineers should work together to provide each other with useful feedback and improve the overall game-design. The creation of a music design document can help this dynamic collaboration by defining what parts of the game should have music, what style of music is best for the game, when the music be ambient or intense, how transitions should be applied or aspects of the game could benefit from musical accents (Witmore, 2003). Correlating sounds to
the type of learning activities and methodologies early in the design process should allow for more effective mood induction techniques and hence improve results.

**Systematic Approach**

It is recognised that despite the obvious educational potential of several video games available on the market, some cannot be used in schools because they are not initially designed to match the environmental needs and curriculum requirements. Even if, in many cases, they increase motivation on the part of the student, it is often difficult to evaluate the knowledge gained due to playing the game; moreover, knowledge transfer can become an issue and there is a need to ensure that mechanisms that maximise knowledge transfer are developed. This lack of transparency and accountability is due to the fact that some of these software packages were designed with no particular learning outcome. On the other hand, developing video games that support particular topics can prove expensive and it is therefore suggested that they could be built with flexibility in mind, allowing teachers to create scenarios based on the lesson in hand (Alessi and Trollip, 2001).

According to Becta (2001), factors influencing the good design of educational games are not only related to the content or structure of the game but essentially to the software design process and the understanding of the real constraints (other than motivation) imposed on both learners and teachers (settings, time, curriculum, etc.). Educational games should be designed to support and complement current teaching practices. For example, when the game is used in the classroom, teachers should be given the opportunity to focus on specific parts of the game to support their lesson plan (e.g. using pre-defined scenarios and scenario builders). They should be provided with tools to create such scenarios and hence decrease the time needed to prepare related teaching. In addition, teachers should be provided with game playing ideas for the classroom and guidance and the way the game might be used (Mc Farlane et al., 2002). An approach based on Analysis, Design, Development, Implementation and Evaluation (ADDIE) should ensure that both educational and motivational objectives are met. It has the potential to address most of today’s educational game pitfalls because it is an iterative instructional design process based on learners’ needs and governed by learning outcomes. It also accounts for the environmental constraints through needs assessment, problem identification and task analysis, and includes an evaluation process to determine the adequacy of the instruction. As suggested by Fullerton (2004) and Rouse (2001), game design is an incremental process whereby new specifications can be discovered as the video game is being developed, however learning objectives and educational outcomes should be specified at an early stage in the process to make sure that the game play allows for learning opportunities.

**Assessing the Model**

A study was carried out to assess the ideas proposed in the PLEASE model. The authors particularly sought to find out whether there was a benefit of displaying time for students with a high level of neuroticism or displaying ranking information for students with a high level of competitiveness. The study also sought to determine if there was a link between users’ personalities and their action during play and if particular game genres were most suitable to specific personalities. The hypotheses were as follows:

- **H1:** Students with a high level of Neuroticism for whom time is displayed during the game will learn significantly better than those for which time is not displayed
- **H2:** Students with a high level of competitiveness for whom ranking information is displayed will learn significantly better that
Profiling Users in Educational Games

students for whom ranking information is not displayed

- **H$_3$:** Students with a low level of conscientiousness whose answers are systematically questioned will learn significantly better than those whose answers are not questioned

- **H$_4$:** Students with a low level of conscientiousness whose answers are not systematically questioned will earn significantly worse than those whose answers are questioned

- **H$_5$:** There will be a statistical difference in game style preferences between students with two significantly different personality profiles

- **H$_6$:** There will be a statistical difference in preferences to seek for information inside the game between students with two significantly different personality profiles

A controlled study was carried out involving 80 students from two secondary schools aged between 13 and 14. Students’ personality was measured through an online questionnaire using the IPIP methodology. The following sections explain the construction of the questionnaire as well as the IPIP methodology.

**Constructing the Personality Questionnaire**

A questionnaire was initially built to measure the students’ personality traits (in the light of the big-5 model) prior to playing the video game. This questionnaire was based on the IPIP and included a total of 50 questions, each assessing a particular personality trait. The reliability of the questionnaire was measured using the split-half method to avoid possible sources of variability (Thorndike, 1949) such as test-wiseness, stable response, health, fatigue, motivation, comprehension or sheer guessing. Results showed that the questionnaire was highly reliable with a confidence of 95%. The validity of the questionnaire was measured to detect if users had answered in a sociably desirable manner and avoid possible bias; an analysis of the standard deviation revealed that only three students answered in a socially desirable manner.

**About the IPP**

Most of the personality inventories developed since 1917 are in the public domain but have a limited bandwidth because they measure three traits at most. On the other hand, broad-bandwidth personality inventories such as the MMPI$^3$, the NEO-PI$^4$ or the 16PF$^5$ are proprietary and therefore cannot be used freely by scientist. These tools are rarely revised, and their validity is not compared to other tools. The IPIP was created to address these issues. It makes it possible provide an accurate, up-to-date and freely available information on personality traits (Goldberg, 1999; Goldberg et al., 2006). The following table illustrates how questionnaire can be constructed using the IPIP including sample questions.

Table 2 illustrates how a questionnaire can be constructed using the IPIP. Questions 1,2,3,4,5 are respectively correlated to Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness. The sign before the question indicates if the question is positively or negatively related to the personality trait assessed. The personality traits are cyclically assessed. For example extraversion is assessed in questions 1,6,11, etc. For every cycle, the sign of the relationship between the personality trait assessed and the question changes. The IPIP used for the personality test includes 50 questions. For each question, subjects need to describe themselves and how they react of feel in particular situations by answering using a five-point Likert scale. Each answer is correlated to a personality trait (Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism). For questions related positively to a personality trait, the answer “Strongly Agree”
corresponded to a score of five, and the answer “Strongly disagree” corresponded to a score of one. If the question is negatively correlated to a personality trait, the answer “Strongly Agree” has a score of one, and the answer “Strongly disagree” has a score of five. The scores are then added for each of the personality traits to determine the resulting levels. To determine if a subject has a high or low level of a particular personality trait, the following method was used in accordance with the NEO-PI-R manual (Costa & Mc Crae, 1992):

- Compute the mean for the set of scores collected for all students
- Compute the standard deviation for the set of scores collected for all students
- Scores within .5 and -.5 standard deviation of the mean are designated as average
- Scores below .5 standard deviation of the mean are designated as low
- Scores above .5 standard deviation of the mean are designated as high

The Experiments

The experiments were conducted as follows:

• Pre-test
• Play the game
• Post-test
• Questionnaire on game preferences
• Questionnaire about the game

The game used for these experiments was a modified version of the initial game MathQuest. Additional features made it possible for the game content to adapt to players’ personality traits.

Knowledge gained was measured by calculating the absolute improvement between pre- and post-tests. Preferences for game styles and information seeking strategies in the game were measured through a questionnaire with a five-point Likert scale for each question. Data was analysed with the Mann-Whitney U test and a factor analysis.

Pupils were invited to take a written pre-test on linear equations and then to play the educational game. They would login into the game using a unique identifier, and their profile and group would be retrieved from a database. The game would then tailor its content and structure (e.g. displaying time, access to ranking information, probing players’ answers) according to the student’s profile. Written pre- and post-tests were used to assess knowledge gained by students.
Questionnaires were provided before and after the experiments to assess students’ preferences for video games, their information seeking strategies in games (e.g. how they would obtain information), to evaluate how they appreciated the game and how it affected or improved their confidence in solving equations.

The pre and post-tests were similar to the tests used in the previous study. The tests were divided into two parts and comprised a total of 10 questions (five questions in each part). In the first part of the test, students were asked to solve a linear equation. They were required to describe all steps used leading to the result. Marks were awarded for the solution and the different steps explained. In the second part of the test, students were given an equation and had to select the next step to solve the equation using an MCQ (Multiple Choice Questions). For this part of the test, answers were mutually exclusive and only one answer was correct. Marks were attributed to correct answers. Tests were taken in a classroom supervised by a teacher. The pre- and post-tests had similar structure and level of difficulty. Students scripts were corrected and results saved on a spreadsheet. The knowledge gained was measured as the difference between the score obtained for the pre-test and the score obtained for the post-test. After the test, students were given a questionnaire evaluating how they felt playing the game had increased their confidence in solving equations and if they would be willing to use the game at home.

Following the collection of data, a statistical analysis was carried out to assess the three hypotheses mentioned previously. Mean and standard deviation of the pre-, post-test and post questionnaire’s answers were measured for each group. A Mann-Whitney test was used to assess the statistical significance of the results. In addition, in the view to determine how personality traits were correlated to information seeking strategies and players’ behaviours in video games, a factor analysis was carried out. The independent (explanatory) variables were the personality traits levels for each student. The dependant variable reflected information seeking strategy and behaviours in games.

For the hypothesis $H_1$ (influence of displaying time for users with a high level of Neuroticism), students who belonged to the experimental group had to complete each level within 12 minutes and the time was displayed in the upper left corner of the screen; students who belonged to the control group did not have any time constraints. Therefore, no time was displayed on the screen.

For the hypothesis $H_2$ (influence of displaying ranking on users with a high level of Competitiveness), students who belonged to the experimental group had to complete each level within 12 minutes. Time and real-time ranking were available in the upper left corner of the screen; students who belonged to the control group did not have any ranking information available on the screen.

For the hypothesis $H_3$ and $H_4$ (influence of probing answers for users with a low level of Conscientiousness), when asked to solve an equation, students were asked to confirm their answer (e.g. "Are you sure this is the correct answer?"). This offered an opportunity for students to reflect upon their answer and to reduce the occurrence of lucky guesses. The frequency of the confirmation messages was based on students’ previous answers (the more accurate the previous answers and the less often the students were asked to confirm their answer). Students who belonged to the control group were never asked to confirm their answer.

For the hypothesis $H_5$ and $H_6$ (influence of personality on game and information seeking preferences) results from the post questionnaire were used to determine trends.

**Influence of Time on Subjects with High Level of Neuroticism**

The following table shows the results for the first hypothesis [Students with a high level of Neuroticism for whom time is displayed during the game will learn significantly better than those for which time is not displayed].
Table 3 shows that displaying time in the educational game for subjects with a high level of Neuroticism increased their proficiency in solving equations. The absolute improvement was almost double (81%) for students with a time limit than for students with no time limit (43%). In addition to the marks for the pre- and post-tests, data from the game was also analysed to evaluate how displaying time in the game affected the time spent by students to solve equations in the game. These results are displayed in Table 4.

Table 4 shows the mean, standard deviation and average time to solve an equation in the game for students with a high level of Neuroticism. On average, students who belonged to the experimental group (time displayed) needed less time to solve equations (81.40 seconds) than students who belonged to the control group (201.90). The average time to solve an equation for students who belonged to the control group was almost twice the average time for all students taking part in the experiments (1.95 times). The standard deviation for the control group was high (212), which means that the students in this group behaved in ways that could not be predicted. However, the low standard deviation for the experimental group indicates that when time is not displayed, students with a high level of Neuroticism have a relatively predictive behaviour.

The Mann-Whitney U-test showed that displaying time in educational games for subjects with high level of Neuroticism had the opposite effect to the one expected: it increased students’ academic results: \((U(14,12) = 39; p = 0.05)\). An additional statistical analysis also showed that the difference in confidence in solving equations (expressed in a post questionnaire) was significantly related to displaying the time in the game \((U(8,5) = 1; p = 0.05)\). (Not all students who played the game had the opportunity to fill-out the post-test questionnaire).

### Influence of Displaying Ranking on Subjects with High Level of Competitiveness

The following table shows the results relative to the second hypothesis [Students with a high level of competitiveness for whom ranking information is displayed will learn significantly better than students for whom ranking information is not displayed].

Table 5 and Table 6 show that displaying rankings in the educational game for subjects with a high level of Competitiveness did not increase their marks but did decrease the time to solve equations.

**Table 3. Post-test results for subjects with a high levels of Neuroticism**

<table>
<thead>
<tr>
<th>Group Type</th>
<th>N</th>
<th>Improvement</th>
<th>Standard deviation</th>
<th>Average for all students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>Control (A)</td>
<td>14</td>
<td>43%</td>
<td>3.43</td>
<td>2.76</td>
</tr>
<tr>
<td>Experimental (B)</td>
<td>12</td>
<td>81%</td>
<td>3.25</td>
<td>3.74</td>
</tr>
</tbody>
</table>

**Table 4. In-Game measurement for subjects with a high level of Neuroticism**

<table>
<thead>
<tr>
<th>Group Type</th>
<th>N</th>
<th>Average time to solve an equation (in seconds)</th>
<th>Standard deviation</th>
<th>Average for all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (A)</td>
<td>14</td>
<td>201.90</td>
<td>212.05</td>
<td>103.18</td>
</tr>
<tr>
<td>Experimental (B)</td>
<td>12</td>
<td>81.40</td>
<td>24.60</td>
<td></td>
</tr>
</tbody>
</table>
equations in the game. On average, time to solve an equation in the game, was almost twice as less for students from the control group (82.37 seconds) than for those who belonged to the experimental group (41.92 seconds).

The raw data does not support the second hypothesis however statistical analysis does not prove that displaying ranking in educational games for subject with a high level of Competitiveness increases their academic results.

A Mann-Whitney U-test has shown that the difference between the two groups for the average time to solve equations in the game can be due to displaying ranking information: \( U(4,6) = 18; p > 0.05 \). This analysis has also shown that the difference in confidence in solving equations (expressed in a post questionnaire) cannot be due to displaying ranking information in the game.

\[ U(3,4) = 6; p > 0.05. \]

**Influence of Probing Students’ Answers on Subjects with Low Levels of Conscientiousness**

Table 7 shows the difference in average knowledge gained and average time to solve an equation in the game between the experimental and control groups. When players had to solve an equation in the game, the tutoring system questioned answers from students who belonged to the experimental group (A) but did not probe answers from students who belonged to the control group (B).

Statistical testing was carried out to evaluate if there was any statistical difference between the two groups. In average, pupils who belonged to the experimental group improved more that the students from the control group. However, the difference in improvement between the two groups was not significant (\( U(19,17)=185, p=0.23 \)).

**Personality Traits and Academic Results**

Table 8 shows the average knowledge gained based on students’ personality traits. It reveals that students with high levels of Openness and Extraversion benefited the most from the use of the educational game (respectively 2.06 and 2.05 increase of marks).

**Players’ Personality and their Preferences**

Another aspect of the study was to determine if players’ personality traits were correlated to preferences for particular game genres (adventure, fps, etc.) and methods to seek information in the game. These were formulated in the hypotheses \( H_5 \) and \( H_6 \):

<table>
<thead>
<tr>
<th>Group Type</th>
<th>N</th>
<th>Average Improvement</th>
<th>Standard deviation</th>
<th>Average for all students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>pre</td>
<td>post</td>
<td>pre</td>
</tr>
<tr>
<td>Control (A)</td>
<td>3</td>
<td>15%</td>
<td>13%</td>
<td>3.52</td>
</tr>
<tr>
<td>Experimental (B)</td>
<td>4</td>
<td>11.3%</td>
<td>10%</td>
<td>3.25</td>
</tr>
</tbody>
</table>

**Table 6. In-game measurement for subjects with high levels of competitiveness**

<table>
<thead>
<tr>
<th>Group Type</th>
<th>N</th>
<th>Average time to solve an equation (in seconds)</th>
<th>Standard deviation</th>
<th>Average for all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (A)</td>
<td>4</td>
<td>82.37</td>
<td>70.29</td>
<td>103.18</td>
</tr>
<tr>
<td>Experimental (B)</td>
<td>6</td>
<td>41.92</td>
<td>25.67</td>
<td></td>
</tr>
</tbody>
</table>
Table 7. Difference in knowledge between experimental and control group

<table>
<thead>
<tr>
<th>Group Type</th>
<th>N</th>
<th>Average knowledge gained</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental (A)</td>
<td>19</td>
<td>1.96</td>
<td>2.47</td>
</tr>
<tr>
<td>Control (B)</td>
<td>17</td>
<td>1.72</td>
<td>2.42</td>
</tr>
</tbody>
</table>

Table 8. Difference in knowledge gained based on students’ personality traits

<table>
<thead>
<tr>
<th>Personality Trait</th>
<th>N</th>
<th>Average Knowledge Gained</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Levels of Openness</td>
<td>11</td>
<td>2.05</td>
<td>1.63</td>
</tr>
<tr>
<td>High Levels of Conscientiousness</td>
<td>9</td>
<td>1.16</td>
<td>1.48</td>
</tr>
<tr>
<td>High Levels of Extraversion</td>
<td>18</td>
<td>2.06</td>
<td>2.5</td>
</tr>
<tr>
<td>High Levels of Agreeableness</td>
<td>11</td>
<td>1.86</td>
<td>2.14</td>
</tr>
<tr>
<td>High Levels of Neuroticism</td>
<td>13</td>
<td>1.36</td>
<td>1.41</td>
</tr>
</tbody>
</table>

- $H_5$: There will be a statistical difference in game style preferences between students with two significantly different personality profiles.
- $H_6$: There will be a statistical difference in preferences to seek for information inside the game between students with two significantly different personality profiles.

A factor analysis was carried-out. The independent variables were the five personality traits of the big-five model (Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism) and dependant variables were successively: (1) tendency to game the system and (2) tendency to ask friends for help. The analysis revealed the following:

- Pupils with low levels of neuroticism are more inclined to game the system (try any possible solution until it worked). The analysis was significant and the five independent variables accounted for 95% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism were respectively 0.092, -0.193, 0.197, 0.079 and -0.516.
- Pupils with high levels of Competitiveness and Extraversion are more inclined to ask friends for help. The analysis was significant and the five independent variables accounted for 74.73% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism were respectively 0.187, -0.118, 0.414, -0.393 and -0.089.
- Pupils with high levels of Openness and Extraversion play video games to discover new levels. The analysis was significant and the five independent variables accounted for 74.84% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism were respectively 0.62, -0.27, 0.54, -0.29 and -0.53.
- No significant correlations were found between students’ personalities and preferred game features (story, video, audio, etc.), character customization, need for reward or preference for online games.
Table 9. Correlations between students’ personality traits and their behaviours in games

<table>
<thead>
<tr>
<th></th>
<th>Openness</th>
<th>Conscientiousness</th>
<th>Extraversion</th>
<th>Agreeableness</th>
<th>Neuroticism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaming the system</td>
<td>0.092</td>
<td>-0.193</td>
<td>0.197</td>
<td>0.079</td>
<td>-0.516</td>
</tr>
<tr>
<td>Ask friends for help</td>
<td>0.187</td>
<td>-0.118</td>
<td>0.414</td>
<td>-0.393</td>
<td>-0.089</td>
</tr>
<tr>
<td>Play to Discover</td>
<td>0.62</td>
<td>-0.27</td>
<td>0.54</td>
<td>-0.29</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

Table 9 shows how correlations between student’s personality traits and their behaviour in the game. Strong correlations are underlined. The results revealed that the way in which pupils played and sought information while playing the educational game was to some extent correlated to their personality. It verified the assumptions made based on observation of students’ behaviours while playing MathQuest and justified the need to profile users in educational games and tailor the environments accordingly.

Summary of Findings
Statistical analysis of the results showed that the hypotheses based on educational psychology were not all valid, notably that displaying a time limit for students with a high level of neuroticism had no significant impact on the learning outcomes and that probing answers for students with a low level of conscientiousness (a.k.a. careless students) had no significant effect on their learning performance (p=0.28). However the study did show that displaying ranking information for students with a high level of competitiveness (low agreeableness) affected their learning performance positively. Results give an idea about how competition can drive pupils with a high level of competitiveness to outperform their peers and hence to improve their results. In addition, students with a high level of extraversion and a high level of openness seemed to benefit the most from the game as described.

CONCLUSIONS, IMPLICATIONS AND FUTURE WORK

Conclusion
In the previous sections the authors have explained the basis for the PLEASE model. They have explained and illustrated how emotions and personality traits can influence learning and that they should be accounted for in the design of educational games. Some aspects of the PLEASE model were assessed through a controlled study conducted with the game MathQuest. This study has revealed that adaptive educational games can be beneficial for improved learning outcomes. It has shown that the degree to which students benefit from an educational game can be correlated to their personality profile, but also that the motivation to play video games and strategies to find information in them can be personality-dependent. Overall it suggests that not all students will benefit from a video game but that in some cases, when the settings and options match their preferences and learning style, improvements can be obtained. Despite the sample size used for this study, clear trends have been identified and ought to be confirmed in a larger study.

Implications
The PLEASE model provides guidelines on the customization of the learning environment, however, the state of the user could also be accounted for to increase the dramatic features of the game.
and hence improve focus and motivation just as adaptive games attempt to adapt the game play to users so that their enjoyment is increased. This need for adaptation is due to the diversity across players in their motivations to play and source of enjoyment (Griebel, 2006; Salen & Zimmerman, 2003; Lazzaro, 2004). Because players have different emotional needs, their expectations will differ. Overall, adaptive games make it possible to dynamically adapt the dramatic features of the game to players’ actions and behaviours. Recent studies show that, for example, in massively Multiplayer Online Role Playing Games (MMORPG), players’ motivation to play can be described in a five-dimensional space: Relationship, Immersion, Grief, Achievement and Leadership. To some extent, personality traits can explain players’ behaviours in video games (Hopson, 2001; Griebel, 2006) and more specifically in educational games (Zhou & Conati, 2003). This suggests that user profiling based on personality traits could make it possible to improve individually both motivational and educational aspects of serious games.

**Future Work**

In the previous chapter, the authors have suggested that the format in which information is delivered to players can impact on their motivation and understanding of the topic taught. For example providing exact, true or misleading information might have an impact on learning outcomes based on pupils’ personality traits. They have also suggested that the game-play could also be tailored to suit particular learning styles. Based on these considerations, the authors are developing a game prototype, which is based on the Irish curriculum and supports the teaching of sciences. In this adventure game, an unknown virus has struck the city and the player has just been hired by a company to find a cure to this terrible disease and save the entire population from dying. The game includes multiple-levels through which the player can:

- Find necessary items to conduct experiments,
- Conducting experiments in a lab based on methodologies described in the curriculum,
- Communicate with Non Player Characters (NPCs) who might provide useful explanations on how to conduct experiments successfully (e.g. device needed, methodology, etc.). Some colleagues might not be trustworthy, provide misleading information and sabotage the work of the player.

NPCs can be of different types and provide exact or false information based on the players’ personality. For example, if the player is identified as having a high level of Openness, misleading information is provided, whereas exact information is provided to players with a high level of Neuroticism. In addition, during their conversation with the character, NPCs provide information to players on resources that might match their learning styles. For instance, players with a low level of extraversion might be given the opportunity to gain access to information in a written format. Nevertheless, all types of information format are available to players regardless of their learning style and access to these resources is be monitored to further refine learners’ behaviours in educational games.

A controlled study based on this game should make it possible determining how the game play can effectively be modified dynamically to match students’ learning styles and improve both results and enjoyment. It should also reveal further correlations between players’ behaviours in an educational game and their personality traits.

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ENDNOTES

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2 http://www.sloodle.org
3 Minnesota Multiphasic Personality inventory
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