

Improving the intellectual quotient in online gaming using Artificial Intelligence

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Abstract The craze for multi-player online games is increasing and the reason behind this is emergence of games like PubG. Researchers found that there is a strong, positive correlation between one's performance in online games and conventional IQ tests. Online games are perceived as an addiction. In order to control this, a better understanding of online gamer behavior is very critical for researchers, practitioners, vendors and developers of games. We have found that graphics, non-player characters etc. also seem to help in stimulating intellectual quotient among gamers. Through this paper, we aim to establish a relation between use of Artificial Intelligence in games and improving intellectual quotient in gamers and what more can be done to make them learn something without making the games less engaging. We have conducted focus group discussions and identified those attributes in online games that intellectually stimulate the participants. We then conducted a questionnaire based online survey and filtered out the important factors from larger audience. Following the results of our analysis we have identified that the most important factors of online gaming with respect to our interest are graphics, non-player characters, competitive spirit and battle arenas.

Keywords — Artificial Intelligence, graphics, Intellectual stimulation, mode of play, non-player characters, online games.

I. INTRODUCTION

Online gaming is the most popular gaming mode ever since the breakthrough of internet [1]. There has been an exponential growth of its popularity in recent times given the use of cutting-edge technologies and easy access to the internet [2]. As a consequence of this, there is an increased tendency of getting addicted to online gaming, which is perceived to cause productivity issues within the concerned individuals. An experimental study by [3] explored the influence among social anxiety, networking sites and addiction tendency showed the sample participant's social anxiety was directly proportional with social networking addiction and tendency towards addiction. However, there are also unfelt benefits from online gaming. One such benefit is an improved intellectual quotient among the players by taking advantage of artificial intelligence and augmented reality [4]. In order to make the best use of artificial intelligence, it is very important to understand the factors that drive gamers towards a particular online game [5].

A. Motivation for our research:

The purpose of this literature review is to identify these factors through various research papers and published journals. This literature review also identifies the gaps left and the pointers given by the research papers which support the current research. We also aim to determine the aspects in the present gaming scenario that negatively affect the lives of the gamers [6]. This helps us in predicting the variables that are needed to be enhanced and those that are needed to be controlled in order to make online gaming a useful and an interactive tool to learn and have fun at the same time [7].

B. Usefulness:

Spending abnormal amount of time on online games leads to gaming addiction in many individuals which is equally catastrophic as substance addiction [8]. Extreme cases of online gaming addiction lead to unhealthy diet and lifestyle, relationship issues, increase in violent behaviour and reduced productivity in students and employees [9].

PUBG, an online game based on multiplayer online battle arena (MOBA) is reportedly the world's highest grossing online mobile game at present with a revenue of \$148 million and more than 100 million monthly players [10].

As online gaming industry is booming and is only expected to get stronger, controlling the causes of addiction and making games more useful is needed now more than ever.

C. Benefits to Organizations:

If the causes of addiction are elicited and games are made intellectually stimulating, online games can not only be used for entertainment but also used as tools for job training, simulations on situational awareness, teaching complicating topics in a fairly easy way, behavioural analysis at a subconscious level etc.

Increased applications would help gaming companies enter B2B markets including existing B2C markets. This can help generate an exponential increase in revenues while being



beneficial to the society at the same time. It would also mean an increased brand exposure for gaming companies resulting in an increased brand value.

D. Research Questions/Problem Statements:

The aim of this research was to investigate and improve the user intellectual quotient while playing games by using the latest technologies like artificial intelligence to improve. In terms of participatory gamers, the aim was to investigate different age groups in India on how they perceive online gaming and their involvement. Based on these the intellectual quotient can be increased among the gamers on the basis of the games they play. The Success of the participatory gamer in intellectual activity would be measured in terms of the extent to which different age groups could make use of their intellect in solving problems/missions.

Through this study, we also aim to investigate which factors in a game attract people in the first place so that companies can make use of these factors and come up with games which are not only enjoyable but also enhance the player's skills subconsciously. We aim to provide a clear understanding of how important aspects like non-player characters are in making a game immersive and thereby the scope of enhancing them using AI techniques.

- Finding ways of enhancing the positive aspects like intellectual stimulation using AI techniques in online games.
- Finding out ways of increasing perceived interest in online games using factors other than graphics alone by exploring the idea of implementing AI for game development.

• To find the number of intellect-stimulating (or promoting strategy) games currently existing and reason for their popularity.

• How a gamer's behaviour gets affected by factors like graphics and music that is played in the game and find out in what areas of online gaming AI could be used to augment the Intellectual Quotient of the gamers.

II. LITERATURE REVIEW

A. Effect of online gaming on people's lives:

The article "The Attitudes, Feelings, and Experiences of Online Gamers: A Qualitative Analysis." by [11] in Cyberpsychology and behaviour stated that <u>p</u>sychological motives can be predicted using AI in order to estimate the behavioural pattern. 81% of online gamers are male with an age mean of 28 years, 4% of whom claimed to play more than 70 hours a week [12]. Gamers consider online gaming environment as pleasant, satisfying and providing equality. Collaborative online gaming has comparatively more arousal to violent tasks. Gamers are usually perceived to be more organized in prioritising their day to day tasks but beyond a certain point, they are prone to negative effects like irritability, hypertension and anxiety [13]. Excessive online gaming is very damaging to the extent that it might spoil very important relationships in some cases. Some people even compare online gaming addiction to substance addiction. Spending more time in online games means being social online but antisocial in real world [14]. This leads to neglected hygiene, sleep, diet, work and studies. Addicted gamers often tend to postpone real world tasks like taking shower, doing dishes etc. They unknowingly get sucked into the virtual world. Time in gaming world is different from that in real world and this can often lead to players not realising how much time they spent playing [15].

[16] cited that people often spend more time on online games due to loneliness, boredom, frustration, stress and low self-esteem. Increased viewing of violent and obscene images in online games increases hostility and promotes aggressive behaviour. Gamers don't just learn these things but also rehearse and initiate fighting behaviour in real life due to decrease in self-awareness and minimum concern for social evaluation.

In the article "Addiction to the Internet and Online Gaming", individuals from several age groups like children, adolescents and adults exhibit online gaming addiction. So, it is not just a problem of socially withdrawn adolescents. Below are a few psychological symptoms associated with online gaming addiction.

- Thinking about gaming all the time.
- Feeling bad when one can't play
- Urge to spend more and more time on online games
- Not being able to quit
- Postponement of real-life activities
- Having problems at school, work or at home
- Lying to people in order to spend more time on gaming
- Using gaming to ease bad moods
- Risking loss of significant relationships
- Unsuccessful efforts to reduce game time.

Typically, spending more than 30 hours per week on games is considered as an addiction. Parents, in general have a pathological view of online gaming addiction which is very similar to pathological gambling. Although, this perception can be changed through application of advanced AI techniques in game development [17].

As games are moving towards human to human interaction, there seems to be an increase in number of players in real time [18]. This can help in identifying the user behaviour through cognitive, social influences, which can be obtained from multi-player games. People these days play online games for social identify and personal needs such as getting entertained, interacting with people etc. Control, attention curiosity can be tested [19]. Enjoyment is the most important priority for any online gamer [20]. Flow experience is highly debated. As most gamers get involved in the game and they spend hours playing, lose their self-consciousness says [21] in "Understanding the behavioural intention to play online games". In order to explain the user behavioural intentions, we need to use TAM model. Gender, Age and Prior experience also play an important role as moderators while identifying playing behaviour [22].

Hence, we intend to prove which factors can help game developers to work on incorporating more positive aspects and omit negative aspects in online games using AI.

B. Relevance of AI in online games:

As players get immersed, games become more addictive. AI can control the way a game responds to player behaviour. It can make or break a game. Games were one of the first software systems ever with which humans interacted [23]. So, in a way, games have also contributed to the development of AI. Present day AI is capable of competing against world champion gamers using a technique called "reinforcement learning" offering a more immersive and challenging experience [24]. This proves that the potential of AI goes beyond automation. AI can also significantly improve the quality of graphics using neural networks. AI can detect factors which psychologically effect people [25]. It can process things which traditional methods can't. For example, the number of ways to play chess is more than the number of atoms in observable universe [26]. A traditional algorithm can't handle such cases. This is where AI is highly useful due to its creativity factor. AI can also be used to control the behaviour of cheating in online games using unsupervised machine learning techniques by monitoring unusual behavioural pattern [27]. AI helps in the creation of convincing and realistic illusions relatable to real life in Eno online games. Due to the presence of factors like scores, progress bar, multiple levels, virtual currencies, badges, ranking and countdown clocks in games, AI can be implemented in gamification of learning and training processes in order to make them more interactive, fun and experimentative. Focus on problem based and experiencebased learning can be done in a better way through online gaming. Games provide rewards, set goals to motivate and promote instruction following, competitive spirit and autonomy [28]. But at the same time, they can also promote selfish-competitive behaviour. So, it is important to assess the participant behaviour and make changes accordingly to promote team play using AI [29].

C. Advantages of using AI in online games:

The adaptive AI system used in a game can upgrade each time a game is played using the past data and avoid being predictable. As a result, players become much more vigilant. [30] stated that the use of such systems in games can help improve speed, agility and logical thinking in players. Environment in which the game is played also influences the user experience. It also helps in building competitive spirit and team work.

AI techniques based on supervised learning can help in the enhancement of board games as well [31]. They don't need to give out all the details, instead can limit the number of clues based on the player's intelligence. AI based techniques also provide scope to personalize and customize the game according to one's needs making it possible to design simulations being used for educational purposes as well said [32] in "An Application of Artificial General Intelligence in Board Games".

D. Factors which can be improved using AI:

According to [33]. it is general human tendency to get attracted towards visually appealing material. Images have been in use in the field of communication even before the introduction of words. They provide a sense of authenticity. That is the reason why we represent everything in the form of pictures and charts. It also helps in conveying the message in a better way. This explains the tendency of current generation to get attracted towards visually appealing games with high quality graphics [34].

Serious games are known to be beneficial for learning purposes even better than conventional methods in some cases such as health. But as the main of a game is having fun, it is, in a way contradictory to the concept of serious games [35]. Also, not everybody would be interested in serious games such as simulations. Hence, it would be beneficial to introduce some features of serious games in regular games making them fun and beneficial at the same time.

Most of the video game designing companies these days spend money on making the game as real and believable as possible using high quality graphics. High quality graphics also enhance the experience of the player by providing scope for a much more detailed screenplay [36]. As a result, irrespective of winning or losing, one always chooses to replay the same game. With the introduction of online gaming, this tendency is only increasing day by day as there is something new in the game every time a player plays it. Digital world has become so immersive that it is starting to change the perceptions of people [37].

The type of interface needed for a game depends on the type of interaction between the console and the player. For example, while playing on a touch screen mobile phone, users can just touch the concerned object on the screen as both the input and output spaces are collated [38]. But while playing on a PC or a gaming console like PlayStation or Xbox, they would definitely need some kind of a cursor which can aid in creating an interface between the input and output spaces.



Mobiles provide a unique opportunity to play whenever people want. Online games on mobile can be enjoyed even while standing in buses or trains [39]. As of 2017, there were 193 million active online mobile gamers in US alone and these numbers are only expected to grow as explained by [40] in "5 Ways Technology and AI Are Changing the Gaming Industry". This is a clear indicator that slowly online gaming in mobiles is becoming an obsession. On mobiles, once the game is downloaded, it can receive instant updates. Due to this, physical purchase of games seems less attractive and people get more attracted towards online multiplayer games.

For the question "How is artificial intelligence used in video games?", David Delony from Technopedia said Artificial Intelligence (AI) in online games is used mostly to design the behaviour of Non-Player Characters (NPCs). In the initial stages, this behaviour was based on a set of predetermined patterns. As most of the developers today are not AI researchers, many of the non-player characters often follow simple predetermined patterns. Gamers these days don't seem to like such characters just staring at blank spaces doing nothing as they get disconnected from the game [41]. AI is also being used in the design of computer opponents. Although playing against a human opponent is always fun, AI helps in analysing the player behaviour and changes the opponent behaviour accordingly. This is known as "emergent behaviour" [42]. It makes the present-day games far more interesting and challenging than their traditional counterparts. Techniques like machine learning, decision trees and path finding are being used for this purpose. IBM's Deep Blue computer defeated Gary Kasparov in 1997 using such techniques [43]. Today's technology is so advanced that computer opponents in battle arenas can even take cover when the player character shoots them. Open world games like GTA V, Watch Dogs, Assassin's Creed, Red Dead Redemption etc allow players to explore a new gaming world with infinite possibilities and unlimited freedom [44]. Now a days, mobile and VR gaming are changing the industry landscape and taking it to another level altogether.

Introducing much more interactive non player characters are also a part of making a game realistic and believable. In modern day, as games are getting more and more sophisticated, non-player characters should also exhibit near human like behaviour to make the players feel connected to the game [45]. The behaviour of such characters can be enhanced to exhibit near perfect human emotions using techniques of artificial intelligence such as neural networks. This idea is emphasised by [46], in "Application of Neural Networks for Intelligent Video Game Character Artificial Intelligences".

Even though non-player characters in most of the presentday games seem intelligent, as the same game is played again and again, their behaviour becomes predictable. This is because traditionally behaviour of these characters is nothing but a bunch of pre-determined patterns repeating again and again. In order to make them less predictable, developers make use of genetic algorithms where the behaviour of these characters changes based on the player's skill level. But this too has its own limitations such as needing huge procession power and time for too little results. Using techniques of artificial intelligence such as neural networks can provide a relatively better solution for this problem as they're proven to complex interactions very well [47]. Since neural networks use forward and back propagation for training, results will only get better with time. So, every time a game is replayed, non-players characters would become more and more human like, unpredictable and interesting, thereby providing a much more immersive gaming experience. Even though the techniques of artificial intelligence have been used in other industries to mimic human behaviour, their application in the field of games is still in its infancy.

[48] in "AI in Computer Games: From the Player's Goal to AI's Role" also said that the aim of any game in development is to provide the same fun experience every time it is played. Opponents who can mimic the human behaviour closest are the most successful ones. Such opponents should not only look realistic by adapting to the player's style but also provide enough challenge while being fair enough at the same time thereby contributing to an improved competitive spirit among players.

AI is usually used in the design of supporting or opponent characters in games. In the earlier days, the only thing that differentiated the opponents from the players is the amount of damage that they could take and do. Now a days, use of artificial intelligence techniques in the design of games has made the opponents use tactical methods and thereby providing new challenges to players to make the game interesting and entertaining [49]. Action games provide the highest scope for the introduction of such characters. They also help in the development of Real Time Strategy games.

Use of AI in sports games can help in improving the quality of the team play as well as the commentary and crowd reactions, thereby providing a much more authentic and realistic experience to the player [50]. This is because, in sports games based on teams, the player usually controls the key player. Rest are controlled by the computer which provides a huge scope for the implementation of AI based techniques. In case of solo games such as racing, it is very annoying when all the other computer driven drivers drive the same way. So, AI based techniques can help in making such games much more realistic and believable. Overall, using AI can help in providing a challenging and enjoyable experience at the same time [51].



With increasing demand for gaming on mobile devices, companies are using Artificial Intelligence and Conceptual Intelligence techniques while designing their games. These games make use of data from sensors which are already present in the devices [52]. This is because mobile devices usually provide much more variety of data in the form of visuals, sound, gps, temperature, speed, proximity etc., which is traditionally not available on desktop-based devices. The presence of these components provides much more data for the AI system to analyse and adapt accordingly in a much more accurate way [53].

Utilising the services like internet and Bluetooth helps in interacting with other players in the same arena of the game providing immense scope to build teams and competitive spirit [54]. And the option of sharing one's accomplishments in the game on social media provides some kind of a motivation to perform better every time one plays it.

Through machine learning and application of AI, identity and behavioural pattern of a person can be known by studying variables like age, education level, socio economic status, BMI, exercise level, smoking and drinking habits, time spent, type of game preferred, mode of play etc. people suffering from Internet Gaming Disorder (IGD) tend to lose executive control over the urge to keep playing and lose focus on real life goals. Use of AI can produce new levels and tailor games to match a player's skill and control unwanted behaviour. Self-evolving and self-executing codes in AI are capable of capturing human intelligence, refine it and create simulations capable of challenging human reasoning in pursuit of certain objectives. This can actually provide an experience equivalent to that of fighting a human gamer when one is actually competing against a computer opponent [55]. AI in online games can also be used in simulation of laboratories, exotic places, historical sites etc resulting in an un-imaginary revolution in education. Creation of the entire ship of Titanic in virtual simulation is one such example. Games could help in creating a virtual world where people could tackle day to day problems. This can help improvise learning from "errors of others".

III. HYPOTHESIS DEVELOPMENT

In this section, we present our hypotheses of direct relationship between some of the attributes of online games and their intellectual stimulations in the gamers. We argue that graphics have an impact on gamers tendency to get attracted towards online games, we further believe it triggers the gamers' intellect [56]. We reiterate that individuals from several age groups like children, adolescents and adults exhibit online gaming addiction and hence we analyse the moderate effects of certain demographic factors like gender, relationship status etc on perceived levels of intellectual stimulation. Based on the previous studies as discussed in the literature review, we hypothesize the following:

H1: Competitive spirit positively effects the perceived level of intellectual stimulation experienced by the user in online games.

H2: Scope – Action based (Open world, battle arena etc.)/ Arcade; of a game has a positive correlation with the perceived level of intellectual stimulation experienced by user in online games.

H3: Quality of Graphics (Boredom, frustration, loneliness, more free time etc) has a positive correlation with the perceived level of intellectual stimulation experienced by user in online games.

H4: Number of interactive non-player characters encountered on an average positively effects the perceived level of intellectual stimulation experienced by user in online games.

H5: Console (Mobile vs PC vs PlayStation vs Xbox) has a positive correlation with perceived level of intellectual stimulation experienced by user in online games.

A. Research Methodology:

Focus Grouped Discussion:

We have conducted focus grouped discussion among two groups as the topic is not sensitive and it is a quicker. We maintained homogeneity within groups and heterogeneity between the groups where one group contained people who play arcade (puzzle-based) video games like Candy crush, Online chess, Ludo, 8 ball pool etc., and the other group contained people who play Multi player online battle Arena based games like Call of duty, Counter strike, PubG and GTA as well. This is because homogeneity within the group provides an open scope for everyone to put forward their points, it ensures that the group doesn't deviate from the topic. Heterogeneity between groups helps in bringing in new ideas and people from different backgrounds. It also eliminates redundancy to some extent.

We ensured that the moderator facilitated the free flow of the discussions without interrupting as long as they remained within the scope of the topic. The group with people who play puzzle-based video games preferred the variables- Reason for playing the game (Boredom, frustration, loneliness), Number of friends or family members playing a similar game and mode of play (mobile Vs PC vs PlayStation Vs X-Box). The group with people who play Multi player online battle Arena preferred the variables- Graphics, scope (open world, battle arena), number of interactive non player characters encountered on an average, mode of play.

The variables that we got from the focused group discussion are Competitive spirit, Mode of play (console), Graphics,



Scope(Action games (open world, battle arena), Arcade games), Number of interactive non player characters encountered on an average, Perceived level of intellectual stimulation by user in a game.

IV. DATA COLLECTION

Online games are being played by many people irrespective or age, gender etc. And also, not all people play the same or similar games. Since there is a high amount of unobserved heterogeneity in the sample being considered and it is relatively difficult to gain direct access to the members of the population, we used Snow ball sampling for data collection where we started with a small sample of respondents and asked them to refer some other respondents who were interested in online gaming.

Since almost all online gamers have access to emails and WhatsApp, we sent our questionnaire based on a 5-point Likert scale with values ranging from strongly disagree to strongly agree through a google form and requested responses. We chose to use a 5-point Likert scale in order to minimize the errors in measurements. We did not choose 7-point or 9-point in order to minimize the effect of confusion among respondents.

We used multiple questions to measure each construct in order to minimize the effect of errors (if any). Since we have designed a long questionnaire with a higher number of items and constructs, in order to avoid monotony and impulse filling, multiple reverse scaling questions have been introduced. And also, we used "counter balancing" by sending questions in different orders to different respondents.As a large sample size was used and unobserved heterogeneity was observed a priori, we had an advantage of internal problems in data getting cancelled out resulting in an improved accuracy.

V. RESULTS

A. Statistics tool used for Analysis: SPSS

B. Reliability Test of the Questionnaire Responses:

Below is the result of Cronbach's Alpha check which checks for the reliability of the data collected.

Responses to all the constructs gave good Cronbach's Alpha where Cronbach alpha for intellectual Quotient is 0.667 which is a dependent variable. The Cronbach alpha for independent variables which are Competitive spirit is 0.762, console is 0.865, Quality of graphics is 0.762, battle Arena is 0.830, Arcade is 0.897 and Non-player is 0.786. These values show that the data collected through survey is reliable and this result tells that we can proceed for further analysis.

Here the dependent variable is the Perceived level of Intellectual stimulation by a gamer and all the other variables are independent variables.

C. Check for Multicollinearity:

In order to check for multicollinearity amongst the independent variables, we have run the correlation matrix. Below are the results of the same:

- 1) Almost all the variables have some form of correlation between each other.
- 2) The non-player variable and the arcade variable have the relatively highest correlation
- 3) Battle arena variable and Graphics variable are also comparatively highly correlated.
- 4) The competitive spirit variable and the console too has significant correlation.

The presence of multicollinearity affects the result as in case of regression analysis, this interdependency amongst the independent variables can give wrong results. The beta coefficients in such cases will be arbitrary and inaccurate. There are some ways to remove the multi-collinearity. Since here the multicollinearity is observed even before creating the interaction terms. We have proceeded to do factor analysis and dimension reduction to remove the multicollinearity. This will help us in getting the factors which explains the independent variables which explains correlations among the variables.

A. Factor Analysis:

B. Factor analysis is done to obtain a smaller set of variables which are uncorrelated such that it they can be used for analysis (Yong & Pearce, 2013). This will also help us to segment data using variables.

Below are the results of dimension reduction and factor analysis in SPSS.There are two components with eigen value greater than 1 which tells that there will be two market segments based on our data. The data explains around 60% of the total variance which is the variance explained by the factors in all variables put together and expressed in unit terms. The extraction of these eigen vectors are done through principal component analysis.

Similar results can be observed through the scree plot with the first two components having eigen values greater than 1. Scree plot tells us the number of factors that needs to be considered by using the eigen values. The data in below component matrix tells us the factor loadings which tells the correlation between the factors and the variables (Çokluk & Koçak, 2016). From the below table we consider which factor is having higher correlation with the variable. This is done for all the variables and based on the selections and its attributes names are assigned for each factor. This can be observed from table 1.



 Table 1: Factor analysis explaining Scree plot and correlation of factors



As per the loadings on the component matrix, we can observe that the dimensions can be reduces to two factors. Factor 1 was loaded highly by competitive spirit, presence of Non-Player characters, console, graphics and battle areas and hence can be named as High-Octane factor. Factor 2 was loaded highly by Arcade as can be names as Soothing factor.

The multicollinearity for above factors indicates that the intercorrelation among the predictors is low, this tells us that there is no collinearity among the factors and we can proceed with the regression analysis.

Multiple regression for analysis? Why?

Our goal of the analysis is to identify the factors that affect the perception of intellectual quotient from online games by the respondents. Depending on the type of our dependent and independent variables, Multiple regression model will quantitatively give us the factors that majorly affect the perception of intellectual quotient in a game by the gamers. In addition to that it will also tell us which factor or covariable is significant to perception of intellectual quotient of gamers and also tells us the most important variable among the significant one. This will help us to know where to focus on the respective games to improve the intellectual quotient.

Below are the dependent and independent variables along with their data types:

Dependent variable:

Perceived level of intellectual stimulation by user in a game – Continuous/metric

Independent variables:

Competitive spirit - Continuous/metric

Quality of graphics – Continuous/metric

Console-Continuous/metric

Arcade - Continuous/metric

Battle arena/MOBA – Continuous/metric

Non player character – Continuous/metric

After the factor analysis, all the independent variables have been reduced to two factors i.e. 'high octane' and 'soothing' factors. These are the names that we have assigned to the variables as they indicate the respective variables. High octane was given as the factor tell about the graphics, spirit, console, non-player characteristics which are important in High octane games. Soothing was given as it tells us about the arcade games, though there are some games which are more intensive in arcade but they are mostly related to fun games and wanted to learn kind of mindset. We have run the regression equation with these two factors along with the covariates.

Covariate addition:

Covariates considered here are age, gender, time spent, relationship status and the type of console. The method followed here is Polytomy (dummy coded regression) as the covariates are categorical variables. The covariates are mainly used to access the relation on the intellectual quotient because gamers perception varies among the above-mentioned covariates. This will help us in identify how females and males perception on the intellectual quotient, how singles or married people perceive it, how time spent can help us in identifying it as some serious gamers play for more than 2 to 3 hours a day and some even play for 1 hour based on their other activities. In addition to all these it will also help us to know which type of console are most people using and which type of console is used for which type of games.

Covariates and their bases for dummy coding:

Type of Console:

Base: Mobile ConsoleType DC1: Desktop/Laptop ConsoleType DC2: PlayStation ConsoleType DC3: Xbox

Gender:

Base<mark>: F</mark>emale – 0; Male - 1

Age:

- Base: 15-20 years
- Age_DC1: 20-25 years

Age_DC2: 25-30 years

Age_DC3: Greater than 30 years

Relationship status:

Base: Single -0; Married -1

Time Spent per day:

Base: 30 minutes

TimeSpent_DC1: 1 hour; TimeSpent_DC2: 1-2 hours

TimeSpent_DC3: greater than 2 hours;

Below are the results of multi-regression model:

The adjusted R Square of the model is 31.2% which is considered to be healthy as we have done dimensional reduction which tells us the overall goodness of fit. The R square is 37.4% which means 37% of the response variable variation is by this model. This can be observed from table 2.



 Table 2: Regression analysis containing the model summary and anova table

Model Summary

Model	R	R Square	Adjusted R	Std. Error of the Estimate
model	IX I	It byuaic	bquare	the Estimate
1	.611ª	0.374	0.312	0.60625

a. Predictors: (Constant), Relationship_DC, HighOctane_Factor, TimeSpent_DC1, Age_DC2, ConsoleType_DC2, Soothing_Factor, ConsoleType_DC3, TImeSpent_DC2, ConsoleType_DC1, Age_DC3, TImeSpent_DC3, Gender_DC, Age_DC1

The degrees of freedom are the number of variables used in our regression model .The regression sum of squares is total variation of dependent variable explained by this model which is (28.737/76.885) =37.81% of all the variables used in this model. The p value is below 5% which means that with 95% confidence level we can tell that there is a linear relationship between the dependent and independent variables.

The model is significant with P value < 0.00001.

The p value here tells us to infer this sample data to the whole population. From this model we have got both the factors as statistically significant, among the console type consoletype_DC3 is statistically significant which is Xbox console, among the time spent variable Timespent_DC3 is statistically significant which is greater than 2 hours, and relationship status is significant.

The coefficients tell you that how much impact that variable have on the dependent variable. HighOctane_factor and Soothing_factor both have a positive coefficient which means that the intellectual quotient would increase by increasing this factor by 1 unit. The console type which is dummy coded tells that mobile console is most loved among the users as the coefficient is negative and we have taken mobile as our reference variable during dummy coding. The Time spent also tells that with 1 unit increase there will be an increase in perception of intellectual quotient of 0.510 and with relationship status with an increase in female user it is likely to increase the perception of intellectual quotient of 0.358. This results about these are tabulated in table 3.

Regression Equation and model estimation:

I.Q percieved = $3.646+$	0.293*(HighOctane_Factor)+			
0.116*(Soothing_Factor)+	0.046*(ConsoleType_DC1)+			
0.095*(ConsoleType_DC2)-	0.458*(ConsoleType_DC3)+			
0.106*(TimeSpent_DC1)+	0.051*(TimeSpent_DC2)+			
0.510*(TimeSpent_DC3)-	0.262*(Age_DC1)-			
0.191*(Age_DC2)- 0.189*(A	Age_DC3)- 0.243*(Gender) +			
0.358*(Relationship Status)				

Table 3: Regression analysis containing the Coefficients table Coefficients^a

		Unstandardized Coefficients		Standardized Coefficients			
			Std.				
Aodel		В	Error	Beta	t	Sig.	
(Constant) HighOctane_Fa r Soothing_Facto ConsoleType_D ConsoleType_D ConsoleType_D TimeSpent_DC TImeSpent_DC TImeSpent_DC Age_DC1 Age_DC2 Age_DC3	(Constant)	3.64 6	0.182		20.036	0.000	
	HighOctane_Facto r	0.29 3	0.059	0.396	4.961	0.000	
	Soothing_Factor	0.11 6	0.057	0.158	2.019	0.046	
	ConsoleType_DC1	0.04 6	0.120	0.029	0.386	0.700	
	ConsoleType_DC2	0.09 5	0.175	0.040	0.541	0.589	
	ConsoleType_DC3	- 0.45 8	0.220	-0.152	-2.084	0.039	
	TimeSpent_DC1	0.10 6	0.144	0.055	0.738	0.462	
	TImeSpent_DC2	0.05 1	0.165	0.022	0.308	0.759	
	TImeSpent_DC3	0.51 0	0.161	0.251	3.166	0.002	
	Age_DC1	- 0.26 2	0.170	-0.180	-1.539	0.126	
	Age_DC2	- 0.19 1	0.182	-0.126	-1.050	0.296	
	Age_DC3	- 0.18 9	0.430	-0.037	-0.440	0.661	
	Gender_DC	- 0.24 3	0.139	-0.146	-1.750	0.083	
	Relationship_DC	0.35	0.176	0.170	2.034	0.044	

a. Dependent Variable: Avg_IQ

VI. DISCUSSION

Research Implications:

We contribute to the existing body of literature by identifying the characteristics of online games that drive people to immerse in online gaming and those that stimulate the players' intellect and improve them using Artificial Intelligence to increase the intellectual stimulations. The characteristics can be categorised into two factors, highoctane factors and soothing or relaxing factors. The highoctane factor includes graphics, presence of non-player characters, competitive spirit, battle arena and console in the order of their loading on the factor. The soothing or relaxation factor includes the arcade nature of the games. It was observed that the high-octane factor in an online game significantly stimulate the intellectual quotient of the gamers. While the soothing factor too has an impact on the stimulation, its significance level as well as the beta coefficient is far lesser than the high-octane factor. From the above-mentioned hypothesis in the hypothesis section all the hypothesis is having a positive relation with the intellectual quotient, that means H1, H2, H3, H4 and H5 hypothesis are accepted. That means the competitive spirit, scope, quality of graphics, non-player characteristics and



console are having positively effects on the perceived level of intellectual stimulation experienced by the user in online games. Based on the beta coefficients from the coefficients table from the regression analysis we tell by how much factor a variable is dependent or will impact the perceived level of intellectual stimulation.

Further, the covariates console type, the time spent, and the relationship status of the gamers also have an impact on the intellectual stimulation:

• Among the console types, it was found that the gamers have significant intellectual stimulation when they play online games on mobile when compared to Xbox.

• Interestingly desktops and PlayStation do not seem to have an impact on the intellectual stimulation of the respondents.

• The gamers who spend greater than 2 hours seem to have stimulated more than those who play for 30 mins a day.

Managerial Implications:

While there many ways to improve the online gaming experience. We explore how developers can leverage artificial intelligence to improve the intellectual stimulation of the players with the help of some of the key factors identified above [57].

Improving Graphics:

Graphics of the game is found to be the key driver to make online gaming immersive [58]. With the combination of AI and computer-generated graphics, online games can take the gaming experience to another level. The concept of photorealism when incorporated with AI will bring the gamers as closely as possible to the real world [59]. The current practice of using predetermined patterns should be replaced with techniques of AI like neural networks to eliminate predictability.

AI can replace the existing graphics engine to render virtual worlds. Videos from the real world are used to train the AI models to create a whole new world. Machine learning and computer graphics can be combined to do image generations using deep neural networks [60]. As training data, sequences of different cities or people can be fed to the AI models and then segmentation networks can be used to extract high level semantics for those sequences. UE4 engines known for creating powerful real time 3D images can also be incorporated [61]. The gaming characters too can be rendered from the videos of the players and their friends using the same methodology.

In this way, we can bring the gaming experience closer to the real world. The gamers with such an experience can have better intellectual stimulations. Also, the gamer's acumen that is developed while playing the games will not be confined to the gaming world instead it will be used by the them in their real life effectively.

Creating interactive Non-Playing Characters (NPCs):

One aspect of online gaming which has been using AI for a long time is the creation of non-playing characters. These

characters in the game provide adequate level of entertainment as well as fulfil players' expectations from the game [62]. At present, the AI used in the online games though look sophisticated is still far behind the AI technologies used in the other industries. Pro-active non playing characters can be created by training the AI models with player's data there by creating a customised gaming experience for the players. The NPCs, thus created can be modelled to learn even when the human players are not in their vicinity. The scripted sequences that trigger the nonplayer characters as soon as the players encounter them can be customised and changed dynamically according to the gamer's data that includes the emotional state of the player as well [63]. These NPCs can help or challenge the gamers creating stronger intellectual stimulations in them. In order to make the games much more relevant and engaging, certain important characters can be made to look like wellknown personalities using facial recognition and masking techniques [64]. For example, the upcoming Cyberpunk game features Hollywood actor Keanu Reeves. Similarly, certain important characters in games can be made to look like people who they connect with in real world.

Increasing the competitive spirit in online gaming:

As per the results of the survey, it was found that the games that bring out competitive spirit from the gamers are more engaging as well as stimulating. Artificial Intelligence and data analytics can be used to imbibe the spirit of competition among the players by creating interactive dash boards of the players' performance [65]. Predictive analytics that are currently being used to give insights in the games can be remodelled to give competitive insights that help the player to get an edge over the other players playing the game. This can be achieved using dynamic neural network models that take the gamer's playing trends as inputs [66]. This would help players not only predict the opponents move well in advance but also assess what strategy would be the best for them in order to achieve certain objectives.

Battle arena:

It was found that the games like PubG, Battleground etc which have battle arenas as their main theme are most engaging. The immersion levels of the games are too high that the gamers get addicted to these games [67]. Advanced AI can indeed change the dynamics of these games and enhance those features that improve the IQ of the gamers without reducing the immersion levels.

On the other hand, there are certain applications such as "Addicaid" which can sense, when a person is going to be addicted using AI. Apps like these can be enhanced and customised to sense the addiction to games like PubG and suggest precautionary measures to the Parents [68]. This will be very useful as in the coming years, the games are going to be more additive leveraging the power of AI to the fullest.



Console:

It was also observed that the type of console that the gamers use for playing also impact the immersion and stimulation levels [69]. Out of all the console types, mobiles are observed to play a major role in the same. This is because they are portable, easy to use and almost everyone has them. Hence, the gaming companies should develop games that are compatible with all operating systems of mobiles without compromising the above factors. Although, there is no denying that gaming on PC's and consoles like Xbox and PlayStation offers superior experience [70].

Arcade games:

Games like chess, Ludo, Candy Crush etc have been known for challenging the intellect of the gamers for a long time. Using advanced AI in these games can help the players improve their IQ effectively [71]. AI can be used to test these games too by creating virtual players and help them improve their quality. Edu-Games, the games that provide both entertainment as well as education can be created using AI models for gamers of all ages [72]. Games that incorporate domain knowledge say, finance, economics, mechanics etc can leverage AI models to create dynamic and interactive components that would increase the engagement and the awareness of the gamers.

Such level of detailing in games provides companies with a scope for better segmentation of their product as per the content involved and business model. Realistic simulations can also be applied in treating conditions like Autism in kids [73].

VII. CONCLUSION

From our empirical results we can observe that the highoctane factor can contribute significantly in increasing the intellectual quotient in players. This can be through improved graphics, more believable non-player characters etc. Below are a few examples.

From the Figure 1, it is clear that the gameplay of GTA V is much more appealing than GTA 1 as improved graphics using AI have provided more accessibility and features in the form of maps, working traffic signals, pedestrians, realistic landscape etc.





GTA 1 GTA V Figure 1: Improved graphics from GTA I to GTA V providing realistic images

Sources:

https://www.google.com/url?sa=i&url=https%3A%2F%2F www.lifewire.com%2Fgrand-theft-auto-series-812461&psig=AOvVaw3p6BcgFskpwDM0UtaWXoxt&ust =1582881215543000&source=images&cd=vfe&ved=0CAI QjRxqFwoTCMi-n4O08ecCFQAAAAAAAAAAAAAA https://www.google.com/url?sa=i&url=https%3A%2F%2F www.youtube.com%2Fwatch%3Fv%3DTOxuNbXrO28&p sig=AOvVaw0vYy5kyoqeZPqkFc2taNlk&ust=1582881639 648000&source=images&cd=vfe&ved=0CAIQjRxqFwoTC KC8leOz8ecCFQAAAAAAAAAAAAAA

From figure 2, it is evident that the image of a police officer (an interactive non-player character) arresting Nico Bellic, the main character of GTA IV. Making such non-player characters more realistic and believable can subconsciously help in improving the intellectual quotient of the player. This might be by instilling fear of police or by making them follow rules. All the versions of GTA have such non-players characters which may or may not be crucial for the storyline. But they make the game much more realistic and believable resulting in a much more immersive experience.



Figure 2: A non-player character (the police) interacting with Nico Bellic, the player character in GTA IV



Source

https://www.google.com/url?sa=i&url=https%3A%2F%2Fg ta.fandom.com%2Fwiki%2FBusted&psig=AOvVaw0bFPf4 Uw_I-LWMfXVL_fs-

&ust=1582881922019000&source=images&cd=vfe&ved=0 CAIQjRxqFwoTCPCit_W08ecCFQAAAAAAAAAABAJ

Non-player characters need not always be human. From figure 3, even the animals seen in the background are nonplayer characters which can be made interactive. This can contribute in subconsciously teaching the players on being kind to animals as well. At the same time, such games can also make them aware of how life was before the modern age.



Figure 3: Some examples of non-human, nonplayer characters from Red Dead Redemption

Source:

https://www.google.com/url?sa=i&url=https%3A%2F%2F in Ene www.techspot.com%2Fnews%2F77946-did-proof-pcversion-red-dead-redemption-2.html&psig=AOvVaw1uRMnpt0oIsgjjeIMUfUv&ust=1582882299782000&source=images&c d=vfe&ved=0CAIQjRxqFwoTCIjam5628ecCFQAAAAAd AAAABAJ

For example, a new game can be developed on India's freedom struggle where movements like Quit India can become individual missions. Similar games have already been developed. The D-day mission in Call of Duty is a mission in which the player is actually placed as one of the soldiers who landed on the shores of Normandie as a part of the allied invasion of German occupied Europe in World War 2. While games based on the financial budgets can also be developed. These can teach a lot about world economy and international trade agreements.

Although, the level of detailing in the game also depends on the console in which it is being player. The insignificance of X-box, PCs and Play station might be due to the unavailability of sufficient data as they offer better experience while playing a game compared to mobiles. But we believe that mobiles have scored high in terms of accessibility. So, companies must utilize this opportunity in using AI to develop games that are intellectually stimulating rather than just providing plain entertainment.

As high-octane games are more likely to attract people, efforts must be made in order to make them more intellectually stimulating by making use of AI techniques to subconsciously improve the thought process and IQ of gamers.

VIII. LIMITATIONS:

As AI collects and trains data related to a given player repeatedly, there might be some kind of a bias introduced in the system overtime [74]. In some cases, it might be too difficult to understand the behaviour of characters developed using AI in games. The use of AI in games demands more computing power and thereby might make gaming experience more expensive. [75] cited that many strategic decisions in real world involve hidden information and this area has been neglected by the AI community. So, AI should not only be used to enhance the gaming experience but also be able to analyse the hidden information and help players in making strategic decisions. **Future scope:**

Gaming industry is growing exponentially and becoming competitive day by day [76]. As a result, use of AI can actually help companies to differentiate their game and retain their market share as well. Games like GTA V provide superior and faster graphics. The results could be much more realistic if AI techniques are implemented. As graphics in a game improve, importance of the non-player characters increases exponentially as they provide interactions with the player's character [77]. So, even though AI implementation in gaming is in its infancy, we believe that it would be the driving factor that would differentiate games in near future.

DECLARATION OF CONFLICT OF INTEREST

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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