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Individualising gamification: An investigation of the impact of learning styles and personality traits on the efficacy of gamification using a prediction market



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ABSTRACT

Gamification is increasingly being used as a way to increase student engagement, motivate and promote learning and facilitate the development of sustainable life skills. Findings from research carried out to date on the effectiveness of gamification in educational contexts can be summarised as cautiously optimistic. However, researchers warn that further and more nuanced research is needed. It is generally accepted that matching an individual's learning style with the appropriate form of an instructional intervention significantly impacts upon the performance of the student and his/her achievement of learning outcomes. It is also widely acknowledged that personality traits have a significant impact on academic achievement. Knowing how individual characteristics will impact on the experience of gamification will inform the effective design of gamified learning interventions and enable its effective integration into the learning environment. This research examines the impact that different learning styles and personality traits have on students'; (1) perceptions of, (2) engagement with and, (3) overall performance in a gamified learning intervention developed using a prediction market. The study evidences a range of responses to gamification based upon individual learning styles and personality traits. Findings suggest that individuals who are orientated towards active or global learning styles have a positive impression of gamification. Other results suggest that extraverted individuals like gamification, while conscientious individuals are less motivated by it. These findings have important implications for practitioners deploying gamification. The key conclusion is that, as a tool for influencing individuals and mediating learning behaviours, gamification must be investigated and deployed in a nuanced manner with due regard paid to issues such as individual learning styles and personality traits.

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1. Introduction

Gamification involves “using game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems” (Kapp, 2012, p. 10). It is a relatively novel concept which is receiving increased attention from academics and practitioners across numerous domains. In particular, its pedagogical applications are the subject of growing interest. Gamification is increasingly being used as a way to increase student engagement, motivate and promote learning and

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facilitate students in the development of sustainable life skills. Research to date on the effectiveness of gamification in educational contexts can be summarised as cautiously optimistic. However, there is widespread acknowledgement in the literature that further research is needed.

It is generally accepted that matching an individual's learning style with the appropriate form of instructional intervention significantly impacts upon the performance of the student and his/her achievement of learning outcomes (Becker, 2005; Cassidy, 2004). It is also widely acknowledged that personality traits have a significant impact on academic achievement (Poropat, 2009). What is not yet known is the impact that learning styles and personality traits have on the efficacy of gamification in an educational context. For example, does gamifying the learning experience have more of an impact on the academic engagement or performance of students who have a preference for processing information actively versus those who are more reflective? Does gamification affect visual learners in a different manner to learners who are verbally oriented? Do extraverts respond better than introverts to a gamified environment? Knowing how individuals' characteristics impact on the efficacy of gamification is necessary to inform its effective utilization. It allows gamification to be included as an element in the suite of pedagogical interventions available to teachers. It can guide the design of holistic learning environments that use gamification to ensure all students receive a positive experience.

This research answers these calls in the literature by investigating how different learning styles and personality traits influence participants' experience of gamification using a prediction market. The macro level contribution of this study is to empirically demonstrate that individuals do respond differently to gamification based upon individual attributes, while specific relationships observed in the data gathered by this study will serve to both guide the design of gamification initiatives in an educational context and inform further research.

The paper is structured as follows. First, an overview of gamification and its pedagogical applications are provided, followed by an examination of the literature on learning styles and personality traits. In the methodology section, the gamified learning intervention used in this study is described and details of the data collection protocol are outlined. The results section reports the findings, which are analysed in detail in the discussion section. Finally, the conclusion section outlines the major findings and discusses their implications for both academics and practitioners and also identifies areas for further research.

2. Literature review

2.1. Gamification

Games prompt powerful emotional responses such as curiosity, satisfaction and frustration (Kim, 2012; McGonigal, 2011). This observation has led to the development of the concept of gamification. Gamification applies the mechanics, dynamics and aesthetics associated with games to non-game contexts (Simões, Redondo, & Vilas, 2013a). It is important to distinguish gamification from the use of computer games in education (Squire, 2003). As well as a plethora of business simulation games, a range of commercial games such as *Civilization*, *Railroad Tycoon* and *World of Warcraft* have been used as learning tools. However, as a pedagogical concept gamification does not necessarily involve the use of an actual game or information technology. Rather, it involves the integration of design elements or activity patterns traditionally found in games into non-game contexts.

The use of game inspired prompts to mediate behaviour is not novel. Notable examples of processes that share at least some of the elements and characteristics associated with gamification include military training simulations, airline frequent flyer miles programs and collectible cards included with consumer products. The first use of the term gamification in its modern sense was by Nick Pelling, who used it to describe techniques used to promote consumer products and services (Werbach & Hunter, 2012).

In order to guide practitioners seeking to gamify activities, Werbach and Hunter (2012) propose a framework that includes a list of elements that can be used to operationalise gamification. This framework describes how these atomic, specific elements can be included in the process or activity to be gamified. The elements identified are listed and defined in Table 1.

Gamification is currently garnering significantly increased attention from both practitioners and academics across a wide range of disciplines. Market research published by Technavio in 2016 estimates that the value of the global gamification market will exceed \$6 billion by 2019 (Technavio, 2016). This interest is seen as a response to the rise of what Davenport terms the "attention economy", where the scarcest economic resource is the attention of individuals (Davenport & Beck, 2002). The posited ability of gamification to attract and hold the attention of employees, customers and other stakeholders is of huge interest to organisations.

There is a growing literature that discusses how gamification can be applied to a wide range of activities, including innovation management (Roth, Schneckenberg, & Tsai, 2015), marketing (Walz & Deterding, 2015), human resources management (Dale, 2014), security (Boopathi, Sreejith, & Bithin, 2015), information technology management (Prakash & Rao, 2015), risk communication (Garvey & Buckley, 2010a) and change management (Roth et al., 2015). Yu-Kai Chou lists over 90 examples of gamification instances, including statistics on Return on Investment (ROI) from the literature (A Comprehensive List of 90+ Gamification Cases with ROI Stats, 2016). Other application domains suggested in the literature include mediating personal productivity (Myhre, 2015), wellness and health (Lister, West, Cannon, Sax, & Brodegard, 2014) and sustainability (McGonigal, 2011; Negrușă, Toader, Sofică, Tutunea, & Rus, 2015).

Table 1
Elements of gamification.

Title	Definition
Achievements	A specific, defined objective within the game
Avatars	A visual representation of a player's character
Badges	A visual representation of achievement
Boss Fights	A particularly hard challenge at the culmination of a level
Collections	A group of related badges
Combat	A zero sum interaction between players for a reward
Content Unlocking	The provision of new content upon reaching an goal
Gifting	The provision of aid to other players
Leaderboards	Allow the direct comparison of players' expertise
Levels	Difficulty moderated based on player expertise
Points	Numeric record of players' performance to date
Quests	Predefined challenges
Social Graphs	Social networks enabled with gamified activity
Teams	Groups of players collaborating to achieve goals
Virtual Goods	Assets with perceived value within the game

One specific domain in which gamification has excited considerable interest is education. Many of the challenges faced by business organisations with regard to the attention economy have direct analogues in the educational domain. These challenges have been exacerbated by the advent of a new generation group, most commonly referred to as 'Millennials' or 'Generation Y' (Elam, Stratton, & Gibson, 2007; Howe & Strauss, 2000). Widely seen as being the first digital natives, they have been exposed to information technology from birth. They are goal focused, confident, team-orientated and socially networked (Howe & Strauss, 2000, 2003; Shih & Allen, 2007). The variety of activities in which they engage has developed their multi-tasking skills and they are seen as being adept at rapidly shifting between tasks and challenges. However these positive attributes are balanced by shortened attention spans and the lack of time and/or skill they expend on engaging in the critical reflection required for developing in-depth knowledge (Howe & Strauss, 2003). These attributes often present significant challenges in an educational setting. With its promise of positively engaging students and mediating their behaviour, gamification is seen as a valuable tool which can be used to address some of the negative behaviours associated with learners in general and with the millennial generation in particular.

This potential has prompted a growing body of literature investigating the utility of gamification in an educational context (Domínguez, Saenz-de-Navarrete, de-Marcos, Fernández-Sanz, Pagés and Martínez-Herráiz, 2013; Lee & Hammer, 2011). Studies have explored the impact of gamification across a range of disciplines such as Computer Science (Browne & Anand, 2013), Finance (Decos, 2015) and Risk Management (Garvey & Buckley, 2010b). Its effect on skills development has been examined in areas such as financial literacy (Decos, 2015) and information literacy (Buckley & Doyle, 2015; Markey et al., 2008). Its effectiveness across the range of educational levels has also been studied including K-6 (Simões, Redondo, & Vilas, 2013b), K-12 (Yurov, Beasley, Kwak, & Floyd, 2014) and higher level education – both undergraduate and post-graduate (Buckley, Doyle, & Doyle, 2016; Urh, Vukovic, Jereb, & Pintar, 2015).

Research to date on the effectiveness of gamification in educational contexts can be summarised as cautiously optimistic. However, there is widespread acknowledgement in the literature that further research is needed. Researchers who are broadly positive as to the pedagogical benefits of gamification also caution that further and more nuanced research in this area is needed. For example, Domínguez et al., 2013, note that “good results don't happen for everyone” (2013, p. 391). On the other hand, Hanus and Fox (2015, p.160), whose work is wary of the benefits of gamification, are careful to caveat their conclusions by noting that it is “important to assess who may benefit the most from gamification”. Nicholson (2012) points out that different activities will appeal to different participants in different ways. He calls for research aimed at understanding how the effects of gamification vary at an individual level. Hamari, Koivisto, and Sarsa (2014) call for research to investigate the role of the qualities and attributes of users when considering gamified learning interventions. Miller, Cafazzo, and Seto (2014) echo this call for research investigating how the characteristics of users impact on the effectiveness of gamification. The importance of these calls is highlighted by related studies which investigate these issues in the context of educational games. Prior research has examined the impact of using a personalised computer game based on learning styles on students' learning motivation and achievement (Hwang, Sung, Hung, Huang, & Tsai, 2012). Findings suggest that both student performance and motivation were enhanced when students are presented with a game which matches their preference for either sequential or global learning. However, further research finds that students are unable to choose educational computer games that fit with their sequential or global learning style (Hwang, Sung, Hung, & Huang, 2013). The learning style element of both these studies was based on the global/sequential element of Felder and Silverman's (1988) model.

In an educational context, two attributes of individuals are particularly important. First, individuals have distinctive personality traits which influence how they experience and perceive the world. Personality traits will influence how individuals react to the behavioural triggers associated with gamified pedagogical interventions. The second important attribute of individuals in an educational context is that of learning style. Individuals have different learning styles which affect how they receive, interact with and integrate educational material. An individual's learning style may have a significant impact on their experience of a learning interaction.

It is generally accepted that matching an individual's learning style with the appropriate form of instructional intervention significantly impacts upon the performance of the student and his/her achievement of learning outcomes (Becker, 2005; Cassidy, 2004). It is also widely acknowledged that personality traits have a significant impact on academic achievement (Poropat, 2009). For gamification to be fully integrated into an educational environment it is necessary to develop a grounded understanding of how personality traits and learning styles mediate an individual's experience of gamification. This imperative has led to repeated calls in the literature for an investigation into how personality traits influence participants' experience of gamification (Hamari & Koivisto, 2015; Miller et al., 2014). The remainder of this paper is concerned with investigating this issue. To ground an investigation of these issues, the literature on learning styles and personality traits is briefly explored.

2.2. Learning styles

An individual's learning style is defined as the manner in which they characteristically approach learning tasks (Hartley, 1998). As mentioned above, matching an individual's learning style with the appropriate form of instructional intervention significantly impacts upon the performance of the student and his/her achievement of learning outcomes (Becker, 2005; Cassidy, 2004). There is an enormous literature on learning styles. One extensive review has identified 71 different learning style models (Coffield, Moseley, Hall, & Ecclestone, 2004). In this context, it can be daunting for a researcher to select an appropriate model (Cassidy, 2004). De Bello (1990) suggests practitioners use three criteria to select a suitable learning style model, namely the match between the purpose of the model and the purpose of the study, the usage of model in the literature and the validity of the associated instrument as reported in the literature.

Following these guidelines, the Index of Learning Styles (ILS) was selected as a model to guide the investigation of students' learning styles (Felder & Silverman, 1988). This model is based on Kolb's (1985) Learning Style Inventory (LSI), which uses a four stage iterative model to describe how learning occurs. Based on this model, Felder and Silverman (1988) adapt this model by proposing that individual learning styles can be categorised along 4 dimensions.

The first dimension, referred to as the sensing-intuiting dimension (Sensing/Intuitive), relates to how a student perceives the world according to their abstraction management skills (Feldman, Monteserin, & Amandi, 2016). Students who have a sensory orientation like learning facts and solving problems using well-established methods. They dislike surprises. They are patient with details, good at memorising and like doing hands on work. They are careful and practical and don't like ideas that have no apparent connection to the real world. Intuitive learners prefer discovering possibilities and the relationships between concepts. They are innovative and dislike repetition and routine. They are good at grasping new concepts and are comfortable with abstractions. They tend to work faster than sensors but may lack attention to detail.

The second dimension relates to how information is most effectively perceived by students (Visual/Verbal). This dimension differentiates students who are visually orientated from students who are verbally orientated. Visual learners tend to prefer visual information transmission methods such as pictures, diagrams, flow charts and time lines, while verbal learners prefer written and spoken explanations.

The third dimension relates to the processing of information (Active/Reflective). Active learners prefer to learn by engaging in an activity related to the learning process, for example a practical project, discussions with others or a physical activity. They tend to like group work. Reflective learners prefer to think about new information and concepts quietly using introspective processes. They prefer to work alone.

Finally, learners may be classified along a dimension that spans sequential to global learners (Sequential/Global). Sequential learners prefer to progress towards understanding in logical, sequential steps, with each step following from the previous one. They also solve problems in this sequential manner. Global learners prefer to develop an initial 'broad brush strokes' understanding of a topic before developing a more detailed understanding of a topic. They may absorb material without necessarily seeing connections and then suddenly 'get it'. They are more likely to solve complex problems quickly or put things together in innovative ways once they have grasped the 'big picture' view, but may have difficulty explaining how they did it.

Felder and Spurlin (2005) note that these dimensions have parallels in many other learning style models and emphasise that this model is similar to many of the competing models.

Using the criteria outlined by De Bello (1990), the ILS is an appropriate model for this study. First, the purpose for which it was developed matches the purpose of this study. The primary objective of the ILS is to "provide guidance to instructors on the diversity of learning styles within their classes and to help them design instruction that addresses the learning needs of all their students." (Felder & Spurlin, 2005, p. 110). This matches the objective of the paper, which is to understand how different learning styles impact on the efficacy of gamification in terms of student perception, engagement and performance, with a view to understanding how it can be effectively introduced into the learning environment. Second, the ILS has been used extensively in educational research. Since 2015, the paper introducing the ILS has been cited over 4500 times according to Google Scholar. Finally, the ILS has been strongly validated in the literature (Cook, 2005; Felder & Spurlin, 2005; Litzinger, Lee, Wise, & Felder, 2007; Zywno, 2003).

2.3. Personality traits

People differ in how they behave in any given situation and in how they perceive and approach demanding tasks, conflicts and opportunities. These differences are attributed to variation in specific personality traits (Gustavsson, Jönsson, Linder, &

Weinryb, 2003). While there is lively debate about the precise definition of personality, there is broad agreement that people have relatively stable behavioural characteristics (Mount, Barrick, Scullen, & Rounds, 2005). Mount et al. (2005, p. 448/9) summarize “Personality traits refer to the characteristics that are stable over time, provide the reasons for the person’s behaviour, and are psychological in nature. They reflect who we are and in aggregate determine our affective, behavioural and cognitive style”. The most commonly used model to provide a coherent taxonomy of personality traits is the Five Factor Model (FFM). The dimensions in the model were originally derived from natural language ensuring that all important aspects of personality are represented (Lynam & Miller, 2015). The second half of the twentieth century saw a number of researchers (e.g., Digman, 1990; Goldberg, 1990) contribute to the development of the model.

The FFM organizes the personality traits of individuals using five dimensions: Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness to Experience (Digman, 1990; Goldberg, 1990). Generally speaking, there is widespread agreement about the five personality dimensions and their content (Mount et al., 2005). Briefly, individuals who are extraverted are outgoing and energetic, while individuals with low extraversion tend to be more solitary and reserved. Agreeableness is a trait that reflects an individual’s concern for society at large. High agreeableness is associated with good-naturedness, cooperativeness and trust in others, while low agreeableness is associated with self-interest and distrust. Conscientiousness is characterised by orderliness, self-discipline and the aim for achievement in terms of externally set measures and metrics. Neuroticism is the tendency to experience and be affected by emotions such as anger or anxiety. Emotional Stability is the opposite. It is associated with individuals who are more phlegmatic and less emotionally reactive. Finally, Openness to Experience is associated with curiosity, flexibility and originality. It is sometimes referred to in the literature as intellect because of its emphasis on intelligence and reflection.

After a long period of debate and validation within the academic community, the FFM has emerged as a widely accepted instrument for use in the measurement and study of personality (McCrae & John, 1992). John and Naumann (2010) reported in 2010 that there had been more than 3000 studies based on the Five Factor model compared with less than half this number using all other personality taxonomies, validating its choice as the personality trait measure for this study.

One of the most common methods of measuring an individual’s personality traits is the Big Five Inventory (BFI), which is a self-report inventory consisting of 44 items (John & Srivastava, 1999). In this study, a 10-term measure of the FFM called the Ten Item Personality Measure (TIPI) is used (Gosling, Rentfrow, Swann, Jr, &., 2003). This instrument has been validated and used extensively in the literature (Ehrhart et al., 2009; Furnham, 2008). As of 2016, over 3100 papers are noted in Google Scholar as using the TIPI instrument. It is specifically designed as a tool to be used in circumstances where researchers have limited time with participants. This was an important consideration as data on Learning Styles and Personality Traits were being collected simultaneously, which created an imperative to minimise the length of the relevant questionnaire in order to improve the accuracy of responses and to diminish the effect that distraction and fatigue would have on respondents. This imperative suggested the TIPI as the optimal data collection instrument for personality traits.

3. Methodology

3.1. Research questions

This study investigates if individuals who have differing personality traits have a different experience of gamification. We operationalised the concept of experience by decomposing it into three variables, namely perception, participation and performance. Similarly, this study aimed to investigate how individual’s learning styles affect their experience of gamification. In a similar vein to the previous analysis, the concept of experience was decomposed into perception, participation and performance.

In summary, our six research questions are as follows:

What impact do different learning styles have on: (1) students’ perceptions of a gamified learning intervention; (2) students’ participation in the gamified learning intervention; and (3) students’ overall performance in the gamified activity?

What impact do personality traits have on: (1) students’ perceptions of a gamified learning intervention; (2) students’ participation in the gamified learning intervention; and (3) students’ overall performance in the gamified activity?

3.2. Procedure

The National Tax Forecasting Project (NBFP) is a gamified learning intervention that asks students to forecast the outcome of the national budget. Annually, The Minister for Finance announces a range of tax policy decisions as part of the national budget. The NBFP uses an on-line prediction market platform to require students to forecast what policy initiatives will be introduced as part of the national budget. This is operationalized by providing students with questions such as “What will the Irish corporation tax rate be after the next budget?”, and a range of potential options:

- < 11%
- > = 11% and <12%
- > = 12% and <12.5%
- 12.5%

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Irish Budget Demo

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QUESTION ENDS
24 October, 2011 @ 07:43pm IST

9632026 commented
Minister for finance announced corporate tax rate would not be changing <http://www.irishtimes.com>

10144533 commented
Report by E&Y Pre-Budget summision recommends leaving corporation tax rate at 12.5%



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What will the Irish corporation tax rate be after the next budget?

POSSIBLE ANSWERS	PREDICTED CHANGE	TODAY
< 11% > more info	11.46%	no change today (€0.00)
>= 11% and < 12%	11.45%	no change today (€0.00)
>= 12% and < 12.5% 12.5%	12.16%	no change today (€0.00)
> 12.5% and < 13%	27.18%	no change today (€0.00)
>= 13% and < 13.5%	12.36%	no change today (€0.00)
>= 13.5%	13.44%	no change today (€0.00)
	11.92%	no change today (€0.00)

Fig. 1. First example of the user interface.

What will the Irish corporation tax rate be after the next budget?
12.5%

Buy Sell

6 shares

Optionally, say a few words about your reasoning

Place trade | Use simple mode

Change chance to: 27.67%

Change price to: €27.67

Available here: €4,575.17

Spend: €164.54

Available after: €4,410.63

You will be buying 6 shares.

CLOSE X

Fig. 2. Second example of the user interface.

- > 12.% and <13%
- > = 13% and <13.5%
- > = 13.5%

The students are given €5000 in virtual cash when the market opens. They use this to invest in the outcome they consider most likely for each question (the contract). The probability of the occurrence of each potential outcome will determine the price the student will have to pay for the contract. Over the course of the project, students trade on the potential outcomes of

Table 2

Presence of gamification elements.

Title	Definition
Achievements	In the NBFP, participants receive rewards for making accurate forecasts about the national budget.
Avatars	Participants have the opportunity to associate an image or icon with their profile.
Badges	Participants receive badges for reaching various milestones, including making a specific number of trades, or making a specific number of comments.
Boss Fights	The prediction market does not directly implement the boss element.
Collections	Participants receive badges for collecting specific sets of subsidiary badges, e.g. specific number of trades combined with a specific level of performance.
Combat	The dynamic of the prediction market implements combat, which is to say that when a participants makes a successful forecast which gains them virtual cash, other participants must have made unsuccessful forecasts which cost them virtual cash.
Content	As time passes, additional forecasting questions are released, providing additional forecasting challenges.
Unlocking	
Gifting	The prediction market does not directly implement the gifting element as participants cannot directly exchange virtual cash. However, participants can exchange information and knowledge on the likelihood of future events using the prediction market's inbuilt communication tools.
Leaderboards	The prediction market implements a leaderboard which shows how each player is ranked against all the other players in terms of virtual cash.
Levels	The levelling element is implicit in the prediction market as participants are competing against other participants who's ability rises over the course of the market due to increased skills developed by growing experience.
Points	Participants receive virtual cash at the start of the market. The amount of virtual cash fluctuates according the accuracy of their predictions, thereby fulfilling the functionality of points.
Quests	The prediction market game incorporates the macro level quest-like objective of creating more accurate forecasts than competitors across the forecasting challenges presented throughout the operation of the market.
Social Graphs	The prediction market software offers a range of communication channels to participants, including a bulletin board, the ability to publicly and privately comment on trades, and the ability to private message other participants.
Teams	The prediction market does not implement the team element, since participants are competing against each other.
Virtual Goods	Participants receive an initial endowment of virtual cash, which they invest in the forecasting problems presented by the prediction market.

up to 14 questions with new questions being added on a regular basis across of range of tax policy areas. They are also required to provide a narrative justification for each trade to evidence rational decision making. Figs. 1 and 2 illustrate the user interface. The NBFP is designed to prompt students to search for information about the budget from sources such as news media, governmental and NGO reports and position papers and recommendations from consultancy firms. Reading and analysing these should improve students' general knowledge of tax, tying the activity back to the relevant learning outcome. Students are free to trade at any stage throughout the three week period of the market. When participants correctly forecast future events (identified when the budget is finally announced), they receive virtual cash increasing their portfolio value and their project grade. At any point during the operation of the market, the market price of a contract represents the consensus of all participants as to the probability of the relevant event occurring. A participant can therefore compare his/her personal estimates to the estimates of the entire class. Unlike a poll, a participant is not limited to making a single estimate. He/she can change decisions at any time in response to feedback or newly revealed information by buying or selling contracts. At an operational level contracts can be bought or sold. The complexity of the system arises from information aggregation and the repeated interactions of large numbers of traders.

This specific learning intervention has been positioned as a gamified learning intervention in the literature (Buckley & Doyle, 2014, 2015). It contains elements associated with gamification. These elements are summarised in Table 2.

3.3. Instruments

The NBFP ran for a three week period. Over this period, a total of 14 separate forecasting problems were presented to the student participants. Empirical data was collected from two main sources. The first was the prediction market software. Amongst other data collected, the prediction market software recorded the time and date of every trade made by every student. Two variables of interest were captured using this data.

The data captured by the prediction market was used to measure an individual's participation. The absolute number of forecasts was used to measure this variable. This metric was appropriate for a number of reasons. Actually placing a forecast is a deliberate, instrumental act on the part of a participant. It requires their conscious participation and a rational decision, which has to be justified by a textual rationale for the forecast.

The second variable that was captured using this data was individual performance. When the national budget was announced at the end of the project, all the individual forecasts made by students could be evaluated as being either correct or incorrect. Students receive virtual cash for correct forecasts, and no reward for incorrect forecasts. Students who make more correct forecasts accrue more virtual cash. Thus, it becomes possible to rank students' performance based on their portfolio of virtual cash. Students were ranked in order of their virtual cash (1st = student with the largest amount of virtual cash, 2nd = student with the second largest amount of virtual cash, and so on). This ranking was used as the metric to measure students' performance.

The second major source of data was an in class questionnaire, distributed to all the students. This questionnaire aimed to capture data pertaining to students' Learning Styles, Personality Traits and their perception of the learning intervention. To this end, the questionnaire contained three main sections. The first section consisted of the ILS instrument; a standardised, validated instrument used to evaluate an individual's learning style. The second section comprised the TIPI instrument, which was used to capture personality traits. The third section asked students to rate their overall perception of the gamified learning intervention using a simple 7 point Likert scale (1 equating to the most negative perception and 7 the most positive). This in-class questionnaire captured data on individual's Learning Style, Personality Traits and Perception of gamification. This data was cross-referenced with the data from the prediction market, which evaluated Participation and Performance, to create the final data set which was analysed to address the research questions.

3.4. Participants

This study involved a class of 158 undergraduate students in their 3rd year of study for a Business Degree. The participants had self-selected to specialise in a major option in Accounting and Finance. As part of this program of study, they undertook a module on Taxation Theory and Practice, which focused on developing their technical skills in the calculation of tax liabilities.

A total of 129 Surveys were distributed to student participants in class. After data cleansing and the removal of surveys which were not completed, 95 valid surveys remained for analysis. After collection and input of the data, it was cross referenced with data gathered by the prediction market. Thus, for each individual surveyed, data on their preferred learning style, their dominant personality trait, their perception of, participation in and overall performance in the NBFP was collected. This rich data set was used to investigate the research questions posed by this study.

4. Results

The relationship between Learning Styles and students' perception of the gamified learning intervention, their engagement with the learning intervention and their overall performance in the learning intervention was investigated using Spearman rho product moment correlation coefficient. A Spearman rho test was used as all the variables being compared were non-parametric. The results of this analysis can be seen in Table 3.

Table 3
Learning styles correlations matrix.

Learning Style Correlation Matrix			Active/ Reflective	Sensing/ Intuitive	Visual/ Verbal	Sequential/ Global	Perception	Engagement	Performance
Spearman's rho	Active/ Reflective	Correlation	1.000	-0.122	0.046	-0.013	-0.208 ^a	0.201	0.169
		Sig. (2-tailed)	.	0.238	0.659	0.903	0.043	0.051	0.103
		N	95	95	95	95	95	95	95
	Sensing/ Intuitive	Correlation	-0.122	1.000	-0.095	0.332 ^b	0.084	-0.019	-0.044
		Sig. (2-tailed)	0.238	.	0.360	0.001	0.416	0.857	0.669
		N	95	95	95	95	95	95	95
	Visual/Verbal	Correlation	0.046	-0.095	1.000	-0.170	-0.108	0.010	-0.041
		Sig. (2-tailed)	0.659	0.360	.	0.100	0.297	0.927	0.690
		N	95	95	95	95	95	95	95
	Sequential/ Global	Correlation	-0.013	0.332 ^b	-0.170	1.000	0.286 ^b	-0.165	-0.235 ^a
		Sig. (2-tailed)	0.903	0.001	100	.	0.005	0.110	0.022
		N	95	95	95	95	95	95	95
	Perception	Correlation	-0.208 ^a	0.084	-0.108	0.286 ^b	1.000	-0.192	-0.294 ^b
		Sig. (2-tailed)	0.043	0.416	0.297	0.005	.	0.062	0.004
		N	95	95	95	95	95	95	95
	Engagement	Correlation	0.201	-0.019	0.010	-0.165	-0.192	1.000	0.219 ^a
		Sig. (2-tailed)	0.501	0.857	0.927	0.110	0.062	.	0.033
		N	95	95	95	95	95	95	95
	Performance	Correlation	0.169	-0.044	-0.041	-0.235 ^a	-0.294	0.219 ^a	1.000
		Sig. (2-tailed)	0.103	0.669	0.690	0.022	0.004	0.033	.
		N	95	95	95	95	95	95	95

^a Correlation is significant at the 0.05 level (2-tailed).

^b Correlation is significant at the 0.01 level (2-tailed).

Three significant relationships were identified by the analysis. There was a small, negative correlation between Active/Reflective and Perception of the intervention, $r = -0.208$, $n = 95$, $p \leq 0.05$. This indicates that active learners have a more positive perception of gamification. Second, there was a small, positive correlation between sSequential/Global and perception of the intervention, $r = 0.286$, $n = 95$, $p \leq 0.01$. This indicates that Global learners have a more positive perception of gamification. Third, there was a small, negative correlation between Sequential/Global and Performance in the gamified activity, $r = 0.235$, $n = 95$, $p < 0.05$. This indicates that individuals who have a global learning orientation performed better in the gamified learning activity.

In order to investigate the relationship between personality traits and students' perception of, engagement with and performance in the gamified learning intervention, a Spearman rho product moment correlation coefficient was again carried out. The results of this analysis can be seen in Table 4.

Three significant relationships are identified. First, there is a small, positive relationship between Extraversion and overall perception of the intervention, $r = 0.222$, $n = 95$, $p < 0.05$. This indicates that individuals who tend towards extraversion have a more positive perception of gamification. Second, there is a small, negative relationship between Conscientiousness and overall perception, $r = -0.238$, $n = 95$, $p < 0.05$. This indicates that individuals who tend towards lower levels of conscientiousness tend to have a more positive perception of gamification. Finally, there is a small, negative relationship between performance and Emotional Stability, $r = -0.204$, $n = 95$, $p < 0.05$. This indicates that individuals who are more emotionally stable tend to perform better in the gamified learning intervention.

5. Discussion

Overall, the results of the data analysis demonstrate a number of relationships between both learning styles and personality traits and perception of, performance in and participation in the gamified learning intervention. The significant relationships are explored in detail in the following sections.

The first relationship that can be identified is a positive relationship between a propensity towards active learning and perception of the gamified learning intervention. This suggests that students who are motivated and engaged by active learning techniques are favourably inclined towards gamification. This relationship has face validity. The primary function of a gamified learning intervention is engaging students in goal directed activities which prompt independent learning and skill development. The inclusion of elements such as leader boards, badges and avatars are focussed on creating an environment

Table 4
Personality traits correlations matrix.

Personality Traits Correlation Matrix			Extraversion	Agreeableness	Conscientiousness	Emotional Stability	Openness	Perception	Engagement	Performance
Spearman's rho	Extraversion	Correlation	1.000	0.010	-0.066	-0.019	0.220 ^a	0.222 ^a	0.082	-0.143
		Coefficient Sig. (2-tailed)	.	0.920	0.528	0.854	0.032	0.030	0.428	0.168
	Agreeableness	N	95	95	95	95	95	95	95	95
		Correlation	0.010	1.000	0.056	0.287 ^b	-0.024	-0.019	0.015	-0.098
	Conscientiousness	Coefficient Sig. (2-tailed)	0.920	.	0.589	0.005	0.817	0.852	0.887	0.347
		N	95	95	95	95	95	95	95	95
	Emotional Stability	Correlation	-0.066	0.056	0.1000	0.056	0.088	-0.238 ^a	0.033	0.103
		Coefficient Sig. (2-tailed)	0.528	0.589	.	0.587	0.396	0.020	0.752	0.318
	Openness	N	95	95	95	95	95	95	95	95
		Correlation	-0.019	0.287 ^b	0.056	1.000	-0.149	0.003	0.035	-0.204 ^a
	Perception	Coefficient Sig. (2-tailed)	0.854	0.005	0.587	.	0.150	0.975	0.734	0.047
		N	95	95	95	95	95	95	95	95
	Engagement	Correlation	0.220 ^a	-0.024	0.088	-0.149	1.000	0.045	0.025	0.136
		Coefficient Sig. (2-tailed)	0.032	0.817	0.396	0.150	.	0.664	0.811	0.190
	Performance	N	95	95	95	95	95	95	95	95
		Correlation	0.222 ^a	-0.019	-0.238 ^a	0.003	0.045	1.000	-0.192	-0.294 ^b
	Performance	Coefficient Sig. (2-tailed)	0.030	0.852	0.020	0.975	0.664	.	0.062	0.004
		N	95	95	95	95	95	95	95	95
	Performance	Correlation	-0.082	0.015	0.033	0.035	0.025	-0.192	1.000	0.219 ^a
		Coefficient Sig. (2-tailed)	0.428	0.887	0.752	0.734	0.811	0.062	.	0.033
	Performance	N	95	95	95	95	95	95	95	95
		Correlation	-0.143	-0.098	0.103	-0.204 ^a	0.136	-0.294 ^b	0.219 ^a	1.000
	Performance	Coefficient Sig. (2-tailed)	0.168	0.347	0.318	0.047	0.190	0.004	0.033	.
		N	95	95	95	95	95	95	95	95

^a Correlation is significant at the 0.05 level (2-tailed).

^b Correlation is significant at the 0.01 level (2-tailed).

that prompts individual action and engagement. It is qualitatively different from more reflective learning interventions such as reading or writing which are internally focussed and introspective in nature.

The second relationship identified by the analysis is that between Global learners and their perception of gamification. Individuals who tend towards global learning have a more favourable perception of gamification. Again, this relationship has face validity. Gamified learning interventions tend to be more holistic than more traditional learning interventions, in the sense that they tend to be inherently irreducible and more than the sum of their parts. Involvement in a gamified activity requires a participant to understand rules, the environment and other participants, and how these elements interact with each other. It is often the case that more traditional learning interventions are reductionist, in the sense that they can be broken up into discrete, independent tasks, which can be completed sequentially one at a time. For example, an essay can be atomised into a series of tasks such as 'Identify research question', 'Conduct literature review', 'Structure Essay' and so on. It logically follows that learners who have a Global learning style would prefer gamified learning interventions which require interaction at that level, while students who prefer to reduce complex problems into individual constituents for analysis suffer by comparison.

This analysis also serves to explain the third relationship between Global learners and overall performance in the gamified learning intervention. One must be careful in drawing conclusions linking learning styles and performance. Such a relationship is almost inevitably dominated by factors such as ability and experience, and the precise nature of the gamified learning intervention is likely to have a major impact. Notwithstanding these caveats, the observed relationship in the data is that individuals with a global learning style tend to outperform students who are more inclined towards sequential learning. The analysis in the previous paragraph provides a ready explanation for this observation. Gamified learning interventions

tend to be complex, interacting systems which are resistant to simple reductionism. Learners whose propensity is to reduce a problem into simpler elements may find that the techniques they usually rely on are not appropriate for the game based context. A gamified environment is a complex system which will often display emergent properties that are not apparent unless viewing the system as a whole. Learners who apply a reductionist approach and seek to break a gamified system into discrete parts may ignore the effect of these emergent properties. If these emergent effects are important, by inadvertently dismissing them, learners can damage their ability to engage effectively with the learning intervention.

Three significant relationships also emerge from the data analysis of individual personality traits. First, there is a positive relationship between extraversion and a positive perception of gamification. Extraversion is a personality trait that manifests in outgoing, energetic behaviour. It is associated with individuals who obtain stimulation and satisfaction from outside the self. Gamification uses leader boards, badges and levels to mediate behaviour. In other words, gamification seeks to use extrinsic motivation to mediate behaviour. Indeed, one of the philosophical criticisms levelled at gamification from a pedagogical perspective is that it is overly focussed on the provision of extrinsic rewards, possibly damaging intrinsic motivation for learning. Leaving this argument to one side, it is unsurprising that individuals who derive energy and satisfaction from extrinsic motivation find gamified learning interventions rewarding. In a very real sense, gamification appeals to the triggers that mediate their behaviour.

The second major correlation observed is that between conscientiousness and the perception of gamification. High conscientiousness is the personality trait linked to individuals who are thorough, careful and precise. It is associated with planned behaviour and manifests in individuals being neat and systematic. The data finds that individuals who are highly conscientious tend to have a more negative perception of gamification. A number of reasons for this can be suggested. First, the unstructured, chaotic, competitive nature of a gamified environment may not appeal to individuals who prefer structure and order. This is particularly the case in an educational context where the ultimate objectives for many students are grades which represent a significant milestone on the way to a successful career. A second explanation is that individuals who like structure and order may find the utilization of gamification, which they associate with play, in a pedagogical environment, which they associate with work, creates cognitive dissonance. A third potential reason is the nature of gamified learning interventions, which rarely contain a definitively correct way to solve a problem. For individuals who tend to be highly goal orientated, the lack of ability to prescribe an approach which will guarantee an optimal solution may be irritating. In summary, while it is unsurprising that those individuals who are highly conscientious are less favourably inclined towards gamification, more detailed work needs to be conducted to investigate the reasons for this relationship.

The final relationship identified is between stability and performance. In general, individuals who are emotionally stable tend to perform better than individuals who tend towards neuroticism. At a general level, gamification is about mediating behaviour by prompting emotions through the provision of extrinsic motivation. While emotion can be a powerful tool to prompt behaviour, it does not necessarily follow that this leads to improved decision making and performance. While a certain level of emotional involvement is necessary in order to prompt action, becoming overly emotional is likely to negatively impact an individual and lead to irrational decision making. The specific nature of this gamified learning intervention was quite competitive, with explicit leader boards and other nudges continually reinforcing an individual's ranking relative to the other participants. While motivating, it is also easy to see how this can prompt negative emotions. Suffering a continual decline relative to other participants may lead to anger, frustration or disillusionment with the gamified activity. Similarly, making a good decision, which initially leads to increased performance relative to other participants, may lead to damaging over-confidence in the long run. Overall, individuals whose emotions are more dynamic are more likely to be impacted by a gamified learning intervention which explicitly seeks to engage students at an emotional level. However, losing detachment and becoming overly emotionally involved in an activity could easily have a negative effect on decision making and ultimately on performance.

6. Conclusions

The key macro level result of this research is the finding that the experience of gamification varies depending on individual attributes. A number of limitations of this study must be noted. This research was conducted in the context of a third level institution. A specific instance of a gamified learning intervention was used, which in turn mandated a specific relationship between the elements of gamification such as leader boards, badges, avatars etc. These factors place limitations on the generalizability of the correlations that were observed. Further research in different contexts is encouraged, both to validate the findings, and to investigate other potential relationships. Nonetheless, the data collected supports the idea that the effect of gamification differs based on the traits of individuals. The key macro level conclusion is that, as a tool for influencing individuals and ultimately mediating behaviour, gamification must be investigated and deployed in a nuanced manner.

From a pedagogical perspective, this research serves to provide guidance as to how better to utilise gamification in an educational context for maximum effect. A number of correlations between both learning styles and personality traits and students' perception of and performance in gamified learning environments have been identified. This suggests a number of key points. First, gamification needs to be carefully integrated into the learning context. In particular, gamified learning interventions should not be introduced as standalone learning activities, but as part of a designed approach integrated at a macro level. It should be introduced in a manner that ensures that individuals with particular learning styles are not systematically discriminated against. Many authors have suggested that traditional learning techniques such as reading assignments and essays disadvantage students who have an active learning style. In this context, the finding that gamification

suits individuals with an active learning style is particularly interesting. It suggests that as a learning intervention, gamification should be seen as a specific tool in the teaching, learning and assessment toolkit, and used as part of a holistic instructional design process that seeks to maximise opportunities for all learners.

In terms of further work suggested by this research, the results make clear the need for more nuanced investigations of gamification. Conceptually, this more nuanced investigation is required along two dimensions. First, much of the literature has tended to treat gamification as a unitary whole. This is counterproductive. A better paradigm is to view gamification as part of a suite of tools that can be used to mediate behaviour. Rather than investigating gamification as a unitary whole, a more nuanced research agenda which investigates how particular elements influence behaviour is likely to be enlightening. This would enable more nuanced and effective design of gamified learning interventions.

Second, the study has focussed on investigating how two particular classes of attributes are related to gamification. The study was aimed at answering specific calls in the literature related to learning styles and personality traits. However, it is reasonable to suggest that other variables, such as age, gender and education are likely to also have significant effects. Investigating these effects is likely to provide a better contextual understanding of gamification, which will again enable more nuanced and effective gamification design when seeking to mediate and promote positive behaviours in both pedagogical and other contexts.

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