Applying the Self Determination Theory of Motivation in Games Based Learning

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Abstract: Game Based Learning (GBL) is often promoted by those who wish to improve learning by increasing pupil motivation. Playing games is considered to be an intrinsically motivating activity. Unfortunately, many GBL games aren't intrinsically motivating. Better understanding and application of motivational models to GBL design may help both GBL designers as well as educators in general make more enjoyable learning experiences. Self Determination Theory (SDT) is a motivational theory that provides a way of understanding human motivation in any context (Deci & Ryan 2000). SDT suggests that humans are motivated by Autonomy, Relatedness, and Competence (ARC). There is a growing body of evidence to support the theory that high perceived support for ARC is related to feelings of high intrinsic motivation (Przybylski et al, 2012, Przybylski, Rigby and Ryan, 2010, Gagne & Deci, 2005). SDT also offers a path from extrinsic, towards intrinsic motivation. If we can apply SDT to games, or education in general, we might be able to improve the experience of the learner such that they perceive activities as enjoyable, interesting and intrinsically motivating. To test whether SDT could encourage and predict engagement in a GBL context, a Serious Game (Career Quest), was designed and implemented. The game taught employability skills to final year "Serious Games" students at Glasgow Caledonian University but the primary purpose of the game was to implement SDT overtly and investigate whether we could measure differences in engagement or motivation for players who had greater or lesser ARC support. 37 students played the game for 10 minutes at the beginning of class over a period of 4 weeks. In addition to this compulsory play session, there was a different, optional challenge daily. Engagement with the daily task was used as an implicit measure of engagement with the intention of validating standard SDT questionnaires that measure engagement. Results indicate that the implementation of the SDT model in this game cannot fully explain levels of engagement. The degree of engagement with the optional Daily Task was not predicted by the either the level of ARC support given to players or a self-report questionnaire that assessed student interest in their Serious Game class. Possible explanations are discussed including the subtle distinctions between objective ARC support and *perceived* ARC support as well as the idea that SDT may require an additional component such as "Purpose" to predict engagement.

Keywords: Games Based Learning, Self Determination Theory, Motivation, Intrinsic Motivation, Extrinsic Motivation, Serious Games

1. Introduction

When games are designed to be used at teaching tools, there is often a trade off between learning content and gameplay content. Game designers and some researchers advocate primary focus being on creating a fun experience (Prensky, 2001); after all, if the game is not fun, who will play it? Others argue that learning should be the main focus of Serious Games (Michael and Chen, 2006); after all, why use a game in education if it doesn't support learning?

An alternative view suggests integrating the learning and fun parts of Games Based Learning (GBL) into bespoke game mechanics that serve both purposes; to be enjoyable and educational, at the same time (Kostkova et al, 2010). This may be an attractive goal for GBL designers but the process by which they can achieve this goal is not clear. Some processes exist for supporting the design process of the cognitive aspect of GBL (Farrell & Moffat, 2013, Farrell & Moffat, 2014) but the affective aspect of design is still largely left to standard game development practices like intuition driven design and playtest driven iteration (Fullerton, 2014). Designers may lean on motivational research science to inform their practice, but much of the research in this area is domain dependent; different models exist that account for motivation in games and motivation in learning.

It isn't enough to make a game engaging - the *way* the game is engaging is important in GBL. Models that explain motivation in both learning *and* play may better inform GBL design practice by offering a different way to make an enjoyable GBL game and may reduce reliance on tried and tested, but perhaps less *useful* methods of creating enjoyable play experiences. Self Determination Theory (Deci

& Ryan 2000) is a well-supported framework that attempts to understand human motivation. It has been applied in many contexts, including education and gaming and has been found to account for individual variations in motivation. The model suggests that people find activities of all kinds enjoyable when they support their basic needs of Autonomy, Relatedness and Competence.
We designed a game to evaluate this approach. The game mechanics were closely aligned to the subject domain and the SDT principles of supporting Autonomy, Relatedness and Competence (ARC). To see whether the level of ARC support was a key factor in engagement, the game was designed to vary the level of ARC support provided, depending on experimental groupings.
The remainder of this paper will examine intrinsic and extrinsic motivation and SDT in some detail before demonstrating how SDT was used to design the game mechanics. Following this, detail is provided on the experiment design before results are presented and discussed.

2. Intrinsic and Extrinsic Motivation

Someone who wants to perform an activity for its own sake is described as being intrinsically motivated and the idea that games are intrinsically motivating (and, conversely, that "education" is not) underpins much of the excitement for the use of games in educational environments.
Intrinsic motivation is often contrasted with extrinsic motivation. An extrinsically motivated individual is undertaking some task not for the task's own sake, but for some external reason or reward. Education is sometimes considered extrinsically motivated because students may feel disinterested in a lesson, but will take part because of an external factor - perhaps they wish to avoid discipline, or to achieve a good mark at the end of the class. People who are intrinsically motivated tend to persist, learn, and perform better in a given task (Vansteenkiste et al, 2004; Broussard & Garrison, 2004) so relying on extrinsic motivation in an educational situation is perceived as sub optimal.

2.1 Motivation and Games Based Learning

By including games in an educational context, some proponents of GBL hope to benefit from the intrinsic motivation of game play and use it to maintain high levels of attention and engagement in the classroom. Edutainment games, where traditional learning tasks are essentially *wrapped* in action game elements are often criticised for offering shallow learning at best, while not providing a particularly rich game experience (Laurel, 2001).
If we consider the role of play in such products, we can see that whilst the action game elements may be intrinsically motivational for players, the learning elements in these games are not - and in fact, the gameplay is serving as an extrinsically motivating reward for 'putting up with' the learning content. Simply sandwiching traditional learning content between game play elements may not prevent the product from being somewhat enjoyable as a whole, but the learning aspects detract from the motivation. Designing game mechanics that are actually relevant to subject material would help reduce the risk of cognitive overload but without relying on tried and tested game mechanics from commercial games (such as racing, or shooting) it is not immediately obvious whether the experience would be engaging for the player.

2.2 The Self Determination Theory of Motivation

Self Determination Theory (Deci & Ryan, 2000; Ryan & Deci, 2000a) offers a theory for understanding human motivation in any general context. SDT is a meta-theory of human motivation comprised of five related mini theories. Unlike other approaches that focus exclusively on a game context (Bartle, 1996; Yee, 2006) or an education context (Ames, 1992; Wentzel, 2000), Self Determination Theory (SDT) recognises that the *experience* of being engaged and motivated is similar across domains. SDT attempts to understand human motivation beyond the simple intrinsic / extrinsic model. It suggests that human motivation varies from fully intrinsic motivation, which is characterised by behaviour that is fully autonomous and "for its own sake" to fully extrinsic motivation, which is characterised by behaviour that is fully heteronomous and which is instrumentalised to some other end.

2.2.1 Self Determination Theory and Intrinsic Motivation

The SDT mini-theory of Cognitive Evaluation Theory (CET) is concerned with intrinsic motivation and suggests that people feel intrinsically motivated when their basic human needs of Autonomy, Competence, and Relatedness (ARC) are met (Ryan & Deci, 2000).
Autonomy is the degree to which someone feels they have agency and control over how they

approach a situation. *Competence* is the degree to which someone feels they are able to complete an activity or the feeling of improvement one gets as they master an activity. *Relatedness* refers to one's role within a social community, the belief that others value an individual and care about them. Contexts and activities that support people's perceptions of having agency and freedom, of having improvement and mastery, of having emotional support and connection have been shown consistently in SDT research to result in high quality, self directed, intrinsic motivation (Niemiec & Ryan, 2009).
Przybylski et al (2012) applied SDT to commercial video games and found that the ARC factors correlate to enjoyment in players. Further, by comparing two games from the same genre, but which differed in success, they found that it was not superficial trappings of video games (such as genre, or degree of violence) that determined how enjoyable they were, but the degree to which they supported players' sense of ARC.

2.2.2 Self Determination Theory and Extrinsic Motivation

The Organismic Integration Theory (OIT) mini-theory of SDT offers a pathway from fully extrinsic motivation to a form of motivation that, whilst partially motivated by contingent, external rewards, shares most experiential aspects in common with an intrinsically motivated activity (Rigby et al, 1992). The central concept of OIT is that as an individual internalises external regulation into their sense of self, the more they will feel and behave as though intrinsically motivated. The OIT mini-theory posits four types of extrinsic motivation differentiated by the degree of autonomy an individual expresses.
The least autonomous and most extrinsically motivated form is known as *external regulation*. Under this form, an individual is only motivated to perform a task for a reward or to avoid punishment.
As an individual begins to incorporate values, attitudes and regulatory structures into their identity, external regulation is transformed to an internal regulation and the individual is more likely to be autonomous in their behaviour. The degree to which an individual integrates these regulatory structures are classified, in order of least to most integration: introjected; identified; integrated.
Introjected regulation is characteristic of an individual who is starting to partially internalise external regulatory factors but still sees them as external to their 'true' self. Someone who experiences guilt when they don't study may be described as experiencing introjected regulation. They don't *feel* like studying, but accept that they *should*. The experience is of being controlled by external factors, but the behaviour is less dependant on moment to moment control by an external agent.
As someone starts to identify that their self selected goals map to behaviours, they experience *identified regulation*. Their identity is as someone who behaves in a certain way and they autonomously behave as though this is the case. A student who strongly values their education feels more freedom and agency in their studies than the introjected student. Someone with identified regulation understands the importance of activities and feels relatively autonomous when performing them, even when they might not traditionally be thought of as interesting.
The most autonomous form of extrinsic motivation is known as *integrated regulation*. With integrated regulation there is a full sense in the individual that their expression of a given behaviour is an integral part of who they are. They feel as though they *want* to perform a task; to take part in an activity. A fully integrated regulation is considered *self determined* as it feels to the individual as though they *want* to take part in the given activity of their own volition. Motivation arising from integrated regulation shares qualities with intrinsic motivation in that it is fully autonomous, of high quality, and not contingent on rewards or punishments. The difference between integrated and intrinsic motivation stems from whether the activity is perceived as fun and interesting on its own (intrinsic) or instrumentally important for personal goals (integrated).
By supporting Autonomy, Relatedness and Competence needs directly in GBL we may be able to alter the form of motivation experienced so that the actual learning content itself in the game is motivational.

3. Designing a Game to Be Engaging with SDT

To investigate the effectiveness of this SDT based approach, an educational game was designed on the principle of offering ARC support through game mechanics that were closely aligned to subject information. Instead of using commercial style game play dynamics to drive engagement, game mechanics were designed that each supported one or more of the ARC basic needs. The game, Career Quest, was developed in collaboration with the University's Careers Service and aimed to teach employability skills to final year game design students. Players control a character who will

soon graduate from university and is trying to better their chances of employment. The students played the game for ten minutes at the start of their Serious Games labs over a period of four weeks.

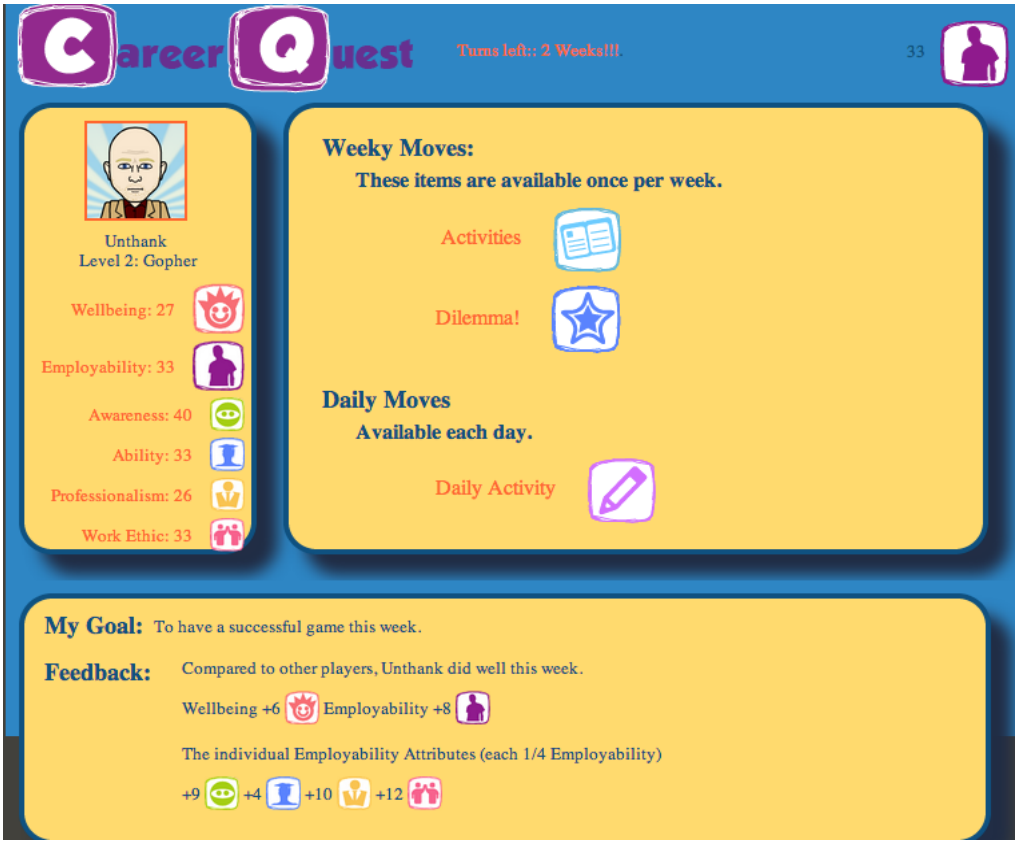

Figure 1: The Career Quest hub screen

Each week, there were two parts of the game that players had to complete. In the Activities section of the game, players were presented with a list of extracurricular activities that their character could choose take part in. Each player had a limited amount of time per week and so had to consider how each activity would benefit their character (i.e. by improving their employability attributes). In the Dilemmas section of the game, players were presented with text representing the kind of real-world moral quandary they may find themselves faced with in the workplace. Players would choose from a list of responses to these dilemmas. Students received feedback on their choices at the start of the following week's play session. There was also an optional Daily Task. This part of the game updated every day and if students wished, they could log into the game from outside their scheduled lab and tell the game that their character had completed the daily activity.

3.1 Varying Autonomy, Relatedness and Competence Support

The game was used experimentally to test the impact of ARC support on player engagement and motivation. The degree to which the game offered Autonomy, Relatedness and Competence support to players was configurable via a database that was used to control the game. Each player was assigned low, neutral, or high Autonomy support; low or high Relatedness support; low, neutral, or high Competence support at random such that players were evenly spread across all combinations of levels.

Each individual's level of ARC support was used to alter the game dynamically. For example, players with high Autonomy support received a version of the game that had several tweaks to better support their sense of agency and control whereas players with low Autonomy support received a version of the game tweaked to give the impression that they had very limited agency and control. Similarly, the game was altered depending on Relatedness and Competence support settings for each player.

3.1.1 Avatar Identification

Prior to the first week of the game all players designed a custom cartoon avatar using the website Bitstrips (Bitstrips.com, 2014). They named their avatar and chose their avatar's gender. Players also completed a questionnaire that was developed by the university Careers Service to measure their knowledge and attitude regarding their employability skills. This questionnaire was assessed and players' avatars were given initial scores in each of a set of employability attributes. Players in the Low Autonomy Support group instead were given an avatar created to be a different race and gender than their designed avatar. Their avatar's initial scores were also set arbitrarily by the researcher instead of being based on their own knowledge. This was to give the impression that their effort was wasted in that avatar creation stage and to reduce their feeling of agency in the game.

3.1.2 Degree of Choice in the Activities Section

In the Activities section of the game, players were given a limited number of time units that represented how their character spend their time over a fortnight of game time. Players with high Autonomy Support could choose 5 from a list of 8 items; medium chose 3 from a list of 5; low chose 2 from a list of 3.

Figure 2: The "Weekly Activities" screen, in which players prepare for graduation

3.1.3 Moral Choices

The Dilemmas part of the game presented students with a difficult scenario where there was no clear moral choice. These Dilemmas represented the kinds of 'grey area' situation one might find themselves in the workplace. Three responses were given to players and each would increase or decrease employability attributes. Players with high Autonomy Support were also offered the opportunity to write their own answer that would be scored and commented on by a Careers Advisor.

Figure 3: The Dilemmas screen where players make a difficult decision

3.1.4 Language Differentiation

Research in SDT has shown that the type of language used can foster or damage perceived SDT support (Rigby et al, 1992). For example, language that appears to restrict freedoms or to control a person makes a task feel less autonomous than that which presents tasks as optional and expressive. Throughout all screens in the game, ARC levels determined which text was shown to players.

Low Autonomy String	Medium Autonomy String	High Autonomy String
Spend your limited time.	Activities.	Plan my week.
Make a difficult decision!	Dilemma!	Show your wisdom!
Required Tasks	Weekly Moves	Weekly Options

Table 1: Text presented to players varied depending on ARC support levels.

3.1.5 Feedback Clarity and Valence

Throughout the game, there were several areas where a score would be shown. The level of detail shown was dependent on the player's level of Competence Support. For example, on the Activities screen shown in Figure 2, there was a space available for each item to show how it would affect the character's various scores. Where low Competence Support players saw no information here, medium Competence Support players saw just one number that represented the Activity's value but were unable to see the underlying components that made up this score. The high Competence Support players were shown a full score breakdown that would allow them to see exactly *how* their character is improving. Players in the low Competence Support group were also presented consistently with negative feedback indicating both that they made poor choices in last week's play session, and that their character would struggle when they graduated whereas those with high Competence Support received positive messages that suggested they were performing particularly well. Players who were in the high Relatedness Support group received a weekly message that was written by a Careers Advisor that commented on their previous week's choices and suggested areas of focus for the current week.

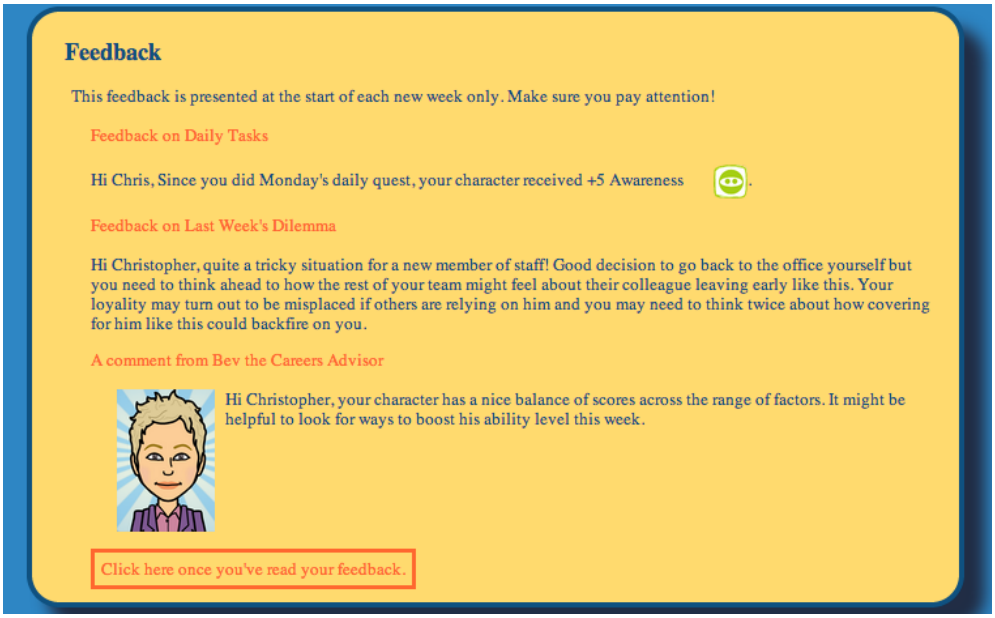

Figure 4: The level of feedback given to players varied depending on ARC support levels

4. Experiment Design

The study aimed to investigate whether designing a game around the principles of offering Autonomy, Relatedness and Competence support was a viable way to create an engaging experience that did not rely on adapting commercial gameplay mechanics as a source of motivation. We hypothesised that those who received more ARC support would find the game more enjoyable, feel more autonomous in their motivation to play and would play the game more. Because the game formed a relatively small part of the overall experience of study in the Serious Games module, it was considered possible that differences in student attitude and interest in their studies may overwhelm any effect that the various ARC support conditions may have. To account for this, participants in the study had their attitude towards the Serious Games module assessed with a questionnaire adapted from the Self Regulation Questionnaire for Learning (Ryan & Connell, 1989). The questionnaire measures the reasons why people learn in university and derives for each individual a Relative Autonomy Index (RAI) that represents how autonomous their motivation is in a given class. Students with more Autonomous motivation have higher engagement with optional activities (Black & Deci, 2000). We expected that If level of ARC did not predict engagement, students' initial attitude might.

4.1 Experimental Groupings

The 37 participants were assigned at random to the cover all 18 permutations of ARC support with at least one participant. The remaining participants were spread throughout, but more were placed at the extremes of support (high or low) to help detect potentially smaller effects.

4.2 Measuring Engagement

The Intrinsic Motivation Inventory (IMI) is a questionnaire that measures subjective experience relative to a given activity. It has been used in several studies to measure interest, enjoyment and self-regulation of subjects' participation in activities (e.g., Ryan, 1982; Ryan, Mims & Koestner, 1983; Plant & Ryan, 1985; Ryan, Connell, & Plant, 1990; Ryan, Koestner & Deci, 1991; Deci, Eghrari, Patrick, & Leone, 1994). Players were asked to complete the questionnaire after each play session.
In addition to the above, explicit measure of engagement, the Daily Task part of the game was designed to be an implicit measure of engagement. A new Daily Task was available each day, not just in the labs where students played the game weekly. Students were not obligated to take part in the Daily Task so the frequency with which they did was expected a reasonable measure of engagement.

5. Results

At time of writing, the explicit, self-report engagement questionnaires have not been examined.

The game's data logs were analysed using the Pearson Correlation Coefficient to investigate possible relationships between the number of times players looked at the optional Daily Task and the various ARC support levels. Each of the individual ARC Support conditions was correlated individually against the Daily Task. The r levels are shown in Table 2.

	Autonomy Support	Relatedness Support	Competence Support
r level	-0.057	0.035	-0.1

Table 2: The varying degrees of basic need support did not predict engagement

As can be seen, the degree of Autonomy, Relatedness and Competence support given to players did not predict the number of times they looked at the Daily Task.
The Relative Autonomy Index values were calculated from the pre-intervention questionnaire and analysed to investigate a possible relationship between student attitude towards their class and the number of times they looked at the optional Daily Task. The r value in this case was 0.32. Although technically a positive correlation, the relationship is weak. Figure 5 shows the RAI scores graphed against the number of looks at the Daily Task.

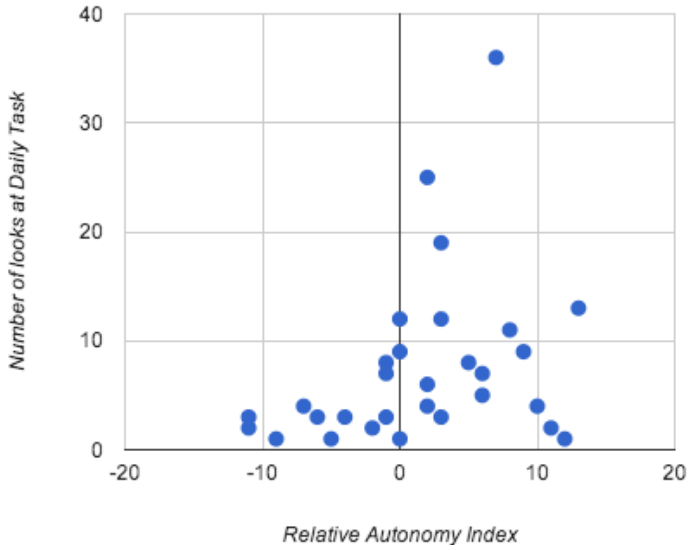

Figure 5: Player RAI was not shown to correlate with engagement.

The graph has three outliers, who each accessed the game at least 50% more than their peers. Removing these outliers results in a correlation with r level 0.44 which is not considered strong.

6. Discussion and Future Work

There is a significant body of work, spread over many international institutions that supports the Self Determination Theory of motivation. As such, it was surprising to find no correlation between either the Relative Autonomy Index *or* the varying levels of ARC support and engagement as measured by the Daily Task. There are several possible reasons that could explain a negative result.
The Self Regulation Questionnaire for Learning that subjects completed was adapted to be relevant to the Serious Games module that the participants were studying. Whilst the game was delivered during this class, the game's content is focused on employability skills. Students may be interested in Serious Games as a field and uninterested in the content of the game. Thus the RAI derived from that questionnaire may be measuring their autonomous motivation towards the wrong subject.
The lack of correlations with the optional Daily Task has been taken to mean that neither student attitude towards their module, nor the level of ARC support led to greater engagement. A different interpretation would be that the use of the Daily Task was not a good measure of engagement. Each Daily Task suggested that players perform some real world act such as to *actually* attend a local game

development meetup or to *actually* create a job-leads spreadsheet. Some players commented in a post-play qualitative questionnaire that they did not have the time to do carry out these tasks and so they stopped checking daily. The Daily Task was the only part of the game to require real-world and time costly participation and even if some players found the game overall to be more engaging or intrinsically motivating, this aspect of it may not have been.

It is also possible that SDT alone does not predict engagement. One can easily conjure scenarios where an individual is not inclined to participate in an activity, no matter how much autonomy that activity offers; no matter how good the individual is at that activity; no matter how much people care for that individual and for the results of that activity. Daniel Pink, in his book Drive (Pink, 2011) writes about SDT and argues for "Purpose" as a key driver of intrinsic motivation. SDT does not account well for Purpose, and cannot really explain the basic valence one feels towards a topic or type of activity at a high level (such as a lack of interest in a topic or field).

We intend to examine the data for explanations of how engagement (both self reported and objective) varied between players and over time. A further study is planned with a larger sample size and we intend to update the game's design to betters support the SDT basic needs.

7. Conclusion

Self Determination Theory is a well-supported framework that explains human motivation in any general situation. This makes SDT well suited for Game Based Learning research which looks to bridge the domains of education and games. SDT research suggests that supporting basic needs of Autonomy, Relatedness and Competence results in a high quality, autonomous form of motivation in situations that would normally be considered extrinsically motivated. A game was designed on SDT principles to offer players some players high levels of support for their ARC needs and some players very little support. The levels of support offered to various players was correlated against the number of times they chose to take part in an optional daily activity. No correlations were found between the number of times the Daily Activity was looked at and the levels of Autonomy, Relatedness or Competence the game offered. Correlations were also investigated between students the level of self-reported autonomy by students at the start of their module and their engagement with the daily task. No correlation was found in this case either. Further work is required to determine whether SDT based approaches to game design are viable.

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