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Constraints and autonomy for creativity in extracurricular gamejams and curricular assessment

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The engagement observed by the players of the games that they play is a desirable quality that has not gone unnoticed in the field of education, leading to concepts such as gamification of education, game-based learning and serious games for training. Game designer Sid Meier is often cited as defining games as being 'a series of interesting decisions'. The concept of choice implies an autonomous selection from a constrained set of options. This article reflects on the impact of autonomy and constraints, and extrinsic and intrinsic motivators on students' software development work during both curricular and extracurricular activities. Finally, a model for the design of games for game-based learning is proposed in terms of autonomy and constraints with respect to learning outcomes.

***Keywords*:** learning; gamejam; extrinsic motivators; intrinsic motivators

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Introduction

Software development is a large part of computer science. The computer programming that underpins this is an objective skill which often requires assembling a precise sequence of ordered instructions that conform to a specific syntax. However, it is often also a very creative process that involves designing and building systems, subsystems and objects in such a way that they exhibit desirable qualities such as efficiency, reliability and maintainability (Hunt, Thomas, and Cunningham 2015). Choosing which qualities are most important, and how best to optimise for those qualities, requires a good deal of creativity. It is proposed that the sheer number of algorithms available to solve the problem of sorting a list of numbers is evidence of the need for divergent thinking in programming. John Romero, founder of id software and creator of the seminal first-person shooter game Doom, describes programming as 'logic-based creativity' (Ewalt 2006).

In this article, the role of constraints and autonomy on student creativity is considered. Firstly, models of intrinsic and extrinsic motivation are presented and autonomy is highlighted as an intrinsic motivator. Following this is an argument that when learning to write a code there is a need for personalised challenges that are well matched to the subject's skill level, together with some of the problems faced in large

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cohorts, where it is tempting to allow students to generate their own challenges as a means of customising each challenge to the individual.

Next, the benefits of extracurricular gamejams to learning are presented as a conduit for students creating their own challenges, along with first-hand experiences of gamejams and efforts to increase diversity and creativity through the application of constraints.

Finally, experiences of providing additional autonomy through coursework are offered together with some empirical data.

Motivation

Motivating factors can often be split into two categories: intrinsic motivators, which originate from within the motivated task itself, and extrinsic motivators, such as financial reward, or marks on an assignment that are not part of the task itself. Ryan and Deci's (2000a) theory of self-determination identifies three intrinsic motivators as competence, autonomy and relatedness.

Ryan and Deci (200b) developed self-determination theory further with the introduction of cognitive evaluation theory and organismic integration theory. Cognitive evaluation theory applies to intrinsically motivated activities and considers the perceived causality and perceived competences of a motivated task, for example, why a subject perceives that he or she is motivated to act and whether a subject perceives an increase in competence from his/her action. An additional extrinsic motivation to act will undermine any intrinsic motivation to act. A perceived increase in competence as a result of an action will increase intrinsic motivation, and a perceived decrease in competence as a result of an action will decrease intrinsic motivation. Organismic integration theory applies to extrinsically motivated activities and acknowledges a range of extrinsic motivators based on the degree to which a subject internalises the causes of extrinsic motivation.

Extrinsic motivators often have a negative impact on creativity. Glucksberg (1962) demonstrated that the presence of extrinsic motivators when presented with a problem to solve resulted in functional fixedness – an inability to think outside of the box. Lepper, Greene, and Nisbett (1973) also demonstrated the negative impact of extrinsic motivators on creativity. Through experimental observations of nursery-aged children's drawing activities in groups that were given no extrinsic reward, an unexpected extrinsic reward or an expected extrinsic reward, they noted that children who received no award or an unexpected reward displayed a slight increase in intrinsic motivation to engage in drawing. Those who were offered an expected reward showed a significant decrease in intrinsic interest. Lepper and Greene also noted a significant decrease in quality associated with expected extrinsic rewards.

Comparisons can be made between the negative effect of extrinsic motivators on creativity on an individual level and the impact of extrinsic motivators on creativity on an industrial level. In the games industry, the top-rated triple-A games require budgets in the order of tens of millions of dollars to make and typically have a relatively poor return of around 7% (McElroy and Gies 2012). The impact of this high-risk, low-return situation is a propensity to an aversion to risk. According to the Entertainment Software Association, of the top-20 bestselling video games of 2016, 17 were sequels of existing games (ESA 2017) and only one game was created with original intellectual property. As a result of the huge budgets and the relatively low

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rate of return, only proven game mechanics and intellectual property can attract the funding necessary to make a triple-A game. Creative and innovative games are seen as too risky to invest in. The extrinsic motivator of profit makes publishers incredibly risk adverse, and unlikely to back anything innovative or creative that does not have a proven track record of success.

Autonomy and challenges for learning

It is proposed that like many skills programming is best learnt through practice. Motivating students to practice programming is not always easy. Often it is difficult to select challenges at an appropriate level for a particular student's skill such that the practice could be useful and engaging. For practice to be useful, it should be challenging. This is supported by Csikszentmihalyi's concept of flow (2014), which requires challenges to be well matched to skill, and by the idea of deliberate practice (Ericsson, Krampe, and Tesch-Römer 1993), which also requires challenges to be specifically tailored to the subject's current skill level. In some cases, especially in large cohorts, it is left to the students to use a process of reflection to identify and fill gaps in their knowledge and skill base. However, requiring this level of autonomous action from students is not always a successful strategy, and even the most engaged students seem to have difficulty in choosing their own challenges. There are three reasons why students find it difficult to reflect upon their own understanding and set appropriate challenges to improve.

The first reason is the lack of comprehension of the bigger picture leading to unfocussed challenges. This phenomenon is similar to the Dunning–Kruger effect (Kruger and Dunning 1999) where students have difficulty understanding what it is they do not understand and so cannot conceive appropriate tasks to stretch themselves and enhance their understanding.

The second reason is the reluctance to take risks leading to very simple challenges relative to the student's skill. This is because in the pursuit of focused challenges there is a tendency for students to consider what they already know, rather than what they need to know. They think of a problem they can solve in terms of the solution they would use rather than thinking of a problem and challenging themselves to find a solution.

The third reason is the lack of awareness of the scope of a problem leading to overambition and choosing goals that are beyond their current ability, and quickly finding that they are struggling with even knowing where to begin. This is not a problem in and of itself as with some appropriate guidance students may well be able to break down a problem into more manageable chunks. The difficulty comes about because of the purpose of the challenge. If the challenge is simply to learn, many students will quickly abandon the challenge as a hopeless endeavour because they cannot make progress (Dweck 2012).

Autonomy and constraints in intrinsically motivated gamejams

Generally, a 'gamejam' is a social event in which individuals or teams come together to make a game within a limited time frame (usually 24–48 h). Typically gamejams are low-risk activities because there are very few significant consequences of failure. With reference to self-determination theory, it seems many gamejam events are intrinsically

motivating, offering ample opportunities for competence, autonomy and relatedness. Participants work in groups and have a great deal of control over the challenges they develop for themselves. Successful completion of a gamejam can result in the perception of increased competence. A gamejam can also offer many additional benefits for its participants. In particular, Smith and Bowers (2016) noted that the self-efficacy of participants drastically improves after taking part in a gamejam. They also noted that qualities that denote strong self-efficacy are a tendency to view problems as challenges to be mastered and the ability to recover quickly from setbacks, whereas qualities of those with weak self-efficacy include a tendency to avoid challenges. Preston *et al*. (2012) considered the motivation of participants and the educational opportunities that they are presented with and showed a correlation between engaging in such extra-curricular events and academic success. Goddard, Byrne, and Mueller (2014) highlighted that gamejams are voluntary, intrinsically motivated ventures which lead to events that are playful in nature.

Global Game Jam

The Global Game Jam is a gamejam that is held at the same time in different locations worldwide with a common theme. Typically it takes place at the end of January and lasts 48 h. It also provides an engaged and enthused community to survey for research purposes. Fowler *et al*. (2013) list many reasons for participation in the Global Game Jam, but one key motivation that is highlighted is the pursuit of learning. In an in-depth analysis of survey results from Global Game Jam 2012, Arya *et al*. (2013) found strong evidence of learning experiences and, in particular, self-efficacy through confidence building. The theme of the Global Game Jam is usually sufficiently abstract to allow significant diversity in the games that are produced and does not usually lend itself to any one type of game. Often it is a picture or a recognisable sound so as to be language agnostic and meaningful all over the world.

The Global Game Jam also offers a set of diversifiers as extra constraints that may inspire creativity. An example of diversifiers is ‘a multiplayer game that requires communication between players, without relying on text or voice’ and ‘played using only the spacebar – no mouse, no other inputs’. These diversifiers present a set of voluntary obstacles for participants to overcome. This playfulness is echoed in Bernard Suits’ (2005) definition of gameplay as ‘the voluntary attempt to overcome unnecessary obstacles’.

It is said that autonomy provides intrinsic motivation to overcome challenges. The inclusion of constraints forces a creative solution. Conventional wisdom tells us that ‘necessity is the mother of invention’. Whilst such playful constraints are by no means compulsory, they force more interesting and innovative solutions.

Three Thing Game

At the University of Hull, the first gamejam event was held in October 2010 in partnership with *360 magazine*, 2010, which covered the event (360 magazine, 2010). The proposal was that all groups make a 2D game entitled ‘Destruction Golf’. The event was deemed a resounding success and of great benefit to students, but there were some very clear improvements that could be made. The biggest issue that required addressing was that the games produced lacked diversity. This meant that it was very easy for

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teams to make comparisons between their game and other games. For future game-jam events, we did not want to give complete freedom as we felt that this would result in many games that were just copies of other games. Instead, the 'Three Thing' brand was conceived in which each group was given a distinct set of three random unrelated things as a theme. Examples include 'Spanish Kumquat Bike-ride', 'Ninja Chickens Painting' and 'School Cheese Escape'. This meant that the games created became hugely diverse, and it was more difficult to make direct comparisons. Over the years, groups have been allowed more autonomy, in the words they are assigned. They have been allowed to suggest their own words for the word pool and to bid an allocation of play money for their words in a word auction. Most recently, due to the size of groups, a one-armed bandit mechanism has been adopted, where each group is allowed three spins and is able to hold words that they would like to keep. It is perceived that this agency reduces the feeling that some word combinations are unfair. The words still offer a good deal of opportunity for creativity and diversity.

It is worth noting that although often there are prizes at our Three Thing game events, the purpose of prize giving is to provide a conclusion to the event. Prizes are not of significant monetary value and are not announced as a draw to the event. There is a perception that when participants are aware of more sought-after prizes, an increase in extrinsic motivation leads to greater levels of stress and conflict within groups, aversion to risk and diminished creativity.

Autonomy and constraints in extrinsically motivated curricular case studies

In assessed coursework, the marks awarded for student submissions can be considered as an extrinsic motivator. As discussed earlier, this has a negative effect on intrinsic motivation in the task. If it was previously an intrinsically motivating task for an individual, the addition of marks shifts the locus of causality towards being extrinsically motivated. In addition, often assessments come with a clear set of goals to guide students towards exactly what they need to do to achieve the credit. This can result in an undesirable lack of autonomy.

Efforts have been made in the past to engage students more fully in the assessment process by offering more autonomy over how they are assessed. Meer and Chapman (2014) allowed students more autonomy with regard to negotiating the marking criteria used for assessment and concluded that involvement in the design of marking criteria allows for a deeper understanding. Hernández (2007) also describes a process of collaboration, feedback and cooperation with the aim of gaining greater engagement in assessment through allowing autonomy in marking criteria. Other forms of autonomy of learning experiences and assessments include the implementation of learning contracts and individual learning goals and targets (Caffarella and Caffarella 1986).

It is difficult to imagine meaningful negotiation in modules with large cohorts of students. As an alternative, students were afforded a greater degree of autonomy in the hope that they would be more engaged in a technically challenging second year module. Students were offered the opportunity to set their own alternative coursework. This was offered alongside a fully specified coursework, which was worth 100% of a second year module in Simulation and 3D Graphics that is part of several computer science degree programmes. In order to set their own alternative coursework, students were required to fill out a form detailing how they would meet a set of technical and functional outcomes, thus ensuring that the same marking scheme could be

applied equally to the students' alternative coursework and the coursework specified by the lecturer. Over 3 years, cohorts of 92, 80 and 104 students were offered this option, but none took it. The perception is that students may not have had a good understanding of the learning outcomes by the time they were required to submit the alternative coursework form, or that they may have considered it too risky to propose their own specification when they already had a specification provided to them.

A further attempt to inspire a greater degree of creativity was made in another second year module in 2D Graphics and User Interface Design. The assessment, entitled 'Do whatever you want*', was worth 50% of the module mark and had no fully specified description available. Students were simply required to submit something that met the learning objectives (the purpose of the qualifying asterisk in the title). Learning objectives were clearly specified and a set of practical labs was provided that also demonstrated the learning objectives. Whilst one route to completing the coursework would be to complete the lab work, students were also awarded a significant proportion (20%) of marks for creativity.

Below is an analysis of marks achieved for demonstrating learning objectives against marks awarded to 139 computer science students in the 2D Graphics and User Interfaces module for creativity as part of the 'Do whatever you want*' assessment. Figure 1 shows normalised marks awarded for creativity versus normalised marks awarded for meeting learning outcomes. There is a strong positive correlation between the two. This data shows a Pearson correlation of 0.628 with a significance at the 0.01 level in a two-tailed test.

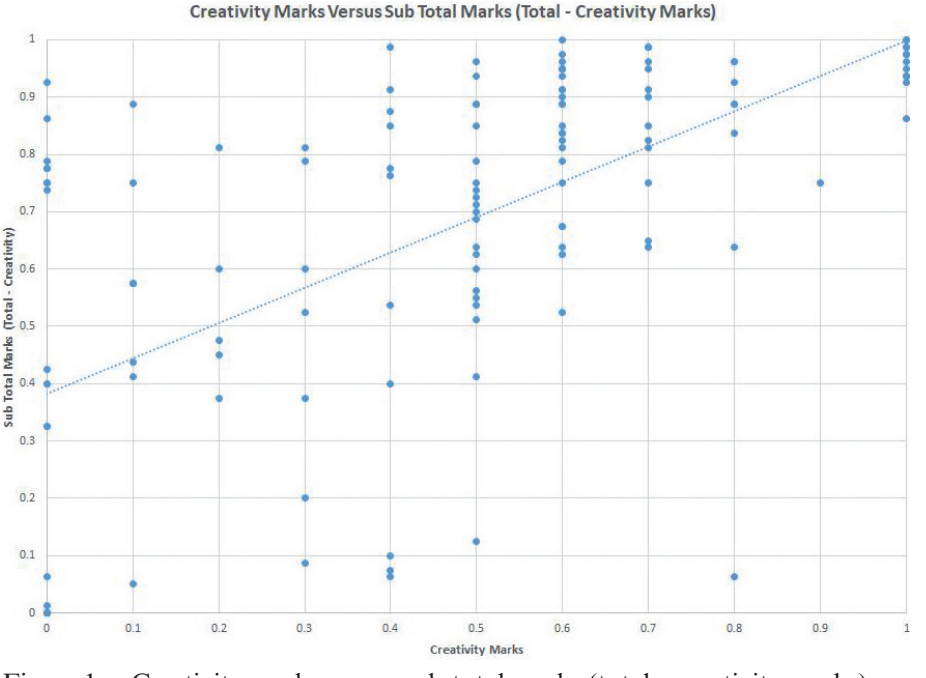

Figure 1. Creativity marks versus sub-total marks (total – creativity marks).

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Discussion

The experiences from the earlier module, in which a specification was provided, could point to students being more risk adverse, especially with the presence of a considerable extrinsic motivator.

The experiences from the module in which students were not supplied with a specification appear to demonstrate that students who were more creatively engaged with their work tended to achieve greater success when meeting the learning outcomes of the module. It could however be argued that students who had already mastered the module concepts had greater freedom (and perhaps time resources) to pursue the 'bonus' marks.

Whilst it is hoped that this autonomy in curricular activities will result in increased engagement of students in their work, another advantage of this approach is that students who exercise their creativity are left with a unique artefact of their work. This is an advantage as a contribution towards a portfolio of work that is often required by potential employers. Habgood (2010) cautions that 'the same demos can appear on the portfolios of all students graduating from a particular university, suggesting that it is actually a tutorial aspect of their course'. Of course, extracurricular activities also offer opportunities to develop compelling portfolio pieces.

In the case of extracurricular activities, it is worth noting that students lend themselves to a self-selecting group of participants who are already intrinsically motivated by the task in hand. Again, these students generate unique pieces of work to add to their portfolio and well and invaluable soft skills associated with working under pressure and in groups.

To summarise, allowing greater autonomy within a given task can provide added intrinsic motivation. Adding additional constraints can yield more diverse and creative outcomes. Adding expected extrinsic motivators can diminish intrinsic motivators and dampen creativity.

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