

# Narrative Elements as a Pedagogical Tool in a Game-Based Context

## Literature Review

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### ABSTRACT

Introductory programming courses pose a challenge to students and teachers alike. This is due, in part, to the fact that students struggle to maintain engagement with the coursework which has a negative effect on knowledge acquisition. Game-Based learning systems for introductory programming have seen an astronomical spike in both theoretical and practical coverage in recent years, yet the question of how they affect student engagement is still under debate. One argument as to why this is the case is that games are too broad of a topic to effectively research and we should instead break gaming down into core elements whose effects on introductory programming can be studied individually. This literary review identifies the narrative element of games as an under-represented and potentially valuable aspect of games that could have a positive influence on student engagement and immersion in an introductory programming course, while negating common points of failure that game-based learning systems encounter.

## 1 INTRODUCTION

Introductory programming has been shown to be a common point of attrition for students looking to study Computer Science [5, 7]. Part of this problem is due to the current pedagogical approaches towards teaching introductory programming. These approaches tend to work for some particular students yet cause many other students to disengage from the coursework [16]. This disengagement has been shown to have a negative effect on knowledge acquisition and information assimilation [40].

Solutions to this problem have been introduced, with game-based learning systems seeing a massive increase in popularity, particularly when it comes to introductory programming, in recent years [19, 47, 50]. This is not without its faults though, as game-based learning in an introductory programming context has seen varied results in the literature. This has been largely attributed to the fact that games, gamification and game-based systems are subject to too much variation and too vaguely defined to yield any pertinent research conclusions [34].

This literature review aims to provide an overview of contemporary game-based learning systems and how they apply to introductory programming courses. Subsequently,

it explores narrative elements of gaming and education, how they have been represented in the research space and if they could be leveraged as a potential means of narrowing down the broad topic of gaming into something that could yield meaningful results [57], while maintaining specificity.

## 2 LEARNING TO PROGRAM

### 2.1 The Problem with Introductory Programming

Learning introductory programming poses a challenge to many students [17, 24]. In fact, there is an inordinately high attrition rate of 30-40% for Computer Science majors, with the majority of them opting to drop out during introductory programming courses [5, 7]. One understanding of this perceived difficulty is due to programming not being a single skill, but rather an application of a set of skills [5]. There is extensive research in this field - towards identifying, describing and preventing causal factors that contribute towards the perceived difficulty and high drop-out rates of introductory programming courses. [51]. Some of these factors have been detailed in the following ways [17]:

- Computer Science programming demands a great deal of abstract understanding and visualization.
- Programming requires the ability to employ practical problem solving techniques.
- Programming often requires a different skill-set, which a student is unlikely to have come across before learning how to program.

Given these factors, it is fair to say that the difficulty of learning to program poses a unique pedagogical question in part because students are expected to employ a variety of skills, while effectively solving unfamiliar problems and absorbing abstract concepts.

### 2.2 Student Engagement and Cognition

Learning introductory programming calls for continued motivation and engagement. This is something that teachers struggle to instill in their students, and students struggle to maintain [16]. Disengagement from introductory programming has been shown to lead to a decrease in student participation, information assimilation and overall knowledge gain [40]. On the other hand, maintained engagement with introductory programming courses tends to result in meaningful acquisition of knowledge [12, 40] and has been shown

to have a statistically significant effect on academic achievement [12]. Interestingly, students tend to approach programming with motivations that stem from different sources [23]. Some students are intrinsically motivated by sheer interest in the coursework whereas others are motivated extrinsically by factors like the desire for financial stability and social pressure. Students that are intrinsically motivated have been found to generally struggle with their programming coursework less than those who are extrinsically motivated [24, 48]. This provides a motive to curate introductory programming courses that are intrinsically motivating in order to increase student engagement and knowledge acquisition within the coursework.

A given student's cognition also comes into play. Learners have been shown to absorb knowledge in different ways. Some students respond positively to static learning environments while others respond to dynamic or interactive learning environments [24]. The challenge in introductory programming courses is then to provide coursework in such a way that these different learning styles are accommodated for so as to maximize knowledge acquisition across different learning styles [53].

Much literature has been written on the topic of how best to design introductory Computer Science courses, accounting for student cognition, learning styles and learning environments [6, 39, 52, 53, 56]. There is still significant debate about best approaches towards teaching introductory programming courses [50], but recent trends in pedagogical strategies for introductory programming have embraced the concept of gamification and game-based learning, with largely positive results [6, 37].

### 3 GAMING & GAMIFICATION

#### 3.1 Gamification and Game-Based Learning

Gamification is a strategic approach that derives from the domain of game design and involves developing information systems and mechanics that incorporate game design elements, which are intrinsically motivating [19], to aid productivity and engagement within a given system [9, 33]. It has garnered much public attention and seen a massive spike in popularity in recent years. According to Seaborn & Fels (2015) [47], this can be ascribed to the astronomic rise of digital gaming as a medium in popular culture. Other researchers [15] argue that 'gamification' as we know it now has existed since the 1980's under the guise of various different names, such as "the science of enjoyable technology" and the study of "hedonic attributes" of games [20]. Regardless of its' origin, gamification and game-based systems have seen a great degree of theoretical research and practical application in recent years [9].

Although gamification has been extensively researched, it suffers from an imprecise definition. It is described by Deterding, Dixon & Khaled (2011) [15] as a means of applying

'gamefulness', 'gameful interaction' and 'gameful design' in non-game contexts. This contrasts other definitions, such as Al-Azawi, Rula & Al-Faliti (2016) [2], who describe gamification as the process in which a system as a whole is turned into a game. For the purposes of this literary review, we introduce the term GBL, or Game-Based Learning to refer to the process of creating a game for the express purpose of teaching something. Game-based learning systems differ from conventional gamification practices in that they do not borrow features and mechanics from game design, but rather they leverage video games as a distinct medium of conveying information [2, 14] and take advantage of unique aspects of gaming to create more comprehensive learning environments and increase knowledge acquisition [2].

#### 3.2 The Anatomy of a Game

What makes something a game turns out to be deceptively difficult to define. Juul (2005) [25] defines games as having six features:

- A rule-based formal system.
- Variable and quantifiable outcomes.
- Players feeling emotionally attached to the outcome.
- An outcome influenced by the efforts that the player exerts.
- Different assigned values for different outcomes.
- Consequences of the activity that are negotiable.

But when one considers the wide variety of game genres that are available today; from strategy, puzzle and card games to role-playing and first-person shooter games, this definition seems to be insufficient [57]. Instead, we introduce Prensky (2001) [41] which describes games as having some, but not necessarily all, of these features:

- Games are a form of fun.
- Games are a form of play.
- Games have rules.
- Games have goals.
- Games are interactive.
- Games are adaptive.
- Games have outcomes and feedback.
- Games have win states.
- Games have competition and challenge.
- Games require problem solving.
- Games have social interaction.
- Games have representation and story.

Games are unique in this sense as there is nothing else, no form of media or practice, that encapsulates, or can encapsulate these elements [41]. There is no one recognized and formal definition of what constitutes a game and the topic of formally defining a game has proven to be surprisingly challenging [19, 22, 57]. However, All games rely on some form of interaction, which provides feedback to the player [19, 41].

### 3.3 Gaming as a Tool for Introductory Programming

Since Game-Based Learning has come into the limelight, it has been heavily tested in the realm of Computer Science education [2, 14, 19, 47, 50, 57]. This is because Computer Science education and Game-Based learning tend to complement each other's flaws.

People tend to find games to be massively engaging [57] and are intrinsically motivated to continue playing [25, 40]. This is of great benefit because consistent engagement with coursework is a challenge for many students and they have been shown to perform better when they engage with their coursework consistently [12, 40]. Research has shown, too, that motivation has a positive effect on knowledge intake [56].

Game-based learning systems provide a visual medium in which to employ practical and puzzle-based problem solving skills [14]. The visual component of these learning systems has been observed to aid interpretation of abstract concepts and to improve student engagement [36]. People also tend to find Game-based systems to be fun and enjoyable [32, 41]. Studies indicate that having fun while programming leads to a higher degree of effort being committed to the practice of learning and results in a more positive approach towards programming [54].

In terms of student cognition and learning systems, students navigating Game-based learning systems are afforded the freedom of interaction to approach the game and the content within it according to their own pacing and desires [31, 57]. This is absolutely crucial for allowing people who are learning to program to incorporate their own learning styles and to adjust the pacing and emphasis of their studies to better suit their needs [53].

Finally, many students study Computer Science in the hopes of going on to make games or study games development [28] and Computer Science students in general are shown to be familiar with popular game mechanics [28, 30], meaning that it is unlikely that the added content of a game will be unfamiliar to them or alienate them from their coursework. All of these factors indicate that Computer Science students as a populace should be well-suited to game-based methods of education in their introductory programming courses.

For the aforementioned reasons, gamification and game-based learning systems ought to be an effective tool to leverage the benefits of gaming in an introductory programming learning context. Yet, the results of research in this domain are inconclusive and incongruent, although largely positive [31, 57]. Young (2012) [57] suggests that these results may be ascribed to the lack of cohesive themes in peer-reviewed articles. They go on to assert that many interesting educational games exist, but the evidence for their impact on academic

achievement and knowledge retention is slim. Another paper, Collier (2009) [14], concludes that preliminary results of introducing game-based systems into mechanical engineering course yielded very encouraging results. However, the evidence they cite is largely anecdotal, with statements such as "[the lead author] has never seen so many students bring their parents, teachers and friends from outside of engineering into the lab to show what they have been doing" to bolster their conclusion.

Other papers conclude that the effectiveness of game-based learning in introductory programming relies on the context in which it is applied [19] and works best when it is utilized alongside other effective pedagogical methods [22, 34]. For example, having a pre-game and post-game discussion or analysis around students playing the game-based learning system.

A common theme in the discussion about game-based systems in introductory programming courses is the fact that different games vary wildly and the concept of a game in general is too loosely defined to have effective research conducted on the effects of game-based systems on introductory programming courses [34, 57]. It may therefore be a better approach to test specific elements of games in an educational introductory programming context because no single experimental variable can be defined to encompass the entirety of what video games may offer [57].

## 4 NARRATIVES & STORY TELLING

Narrative, or storytelling, is a spoken or written account of connected events. It serves to tie linked concepts together to create an over-arching thematic context [18, 43]. As an individual experiences a narrative, they progressively construct models of meaning that represent the elements and characters within the narrative based on experiences and knowledge they already have [11]. Critically, an individual finds themselves updating their mental models as a narrative progresses [58].

Narratives also feature core constructs that describe the manner in which an individual may engage with systems that contain narrative elements [11]. These constructs are:

- Transportation - Absorption into a story. Entails imagery, affect and attentional focus [18]. Different researchers have also defined this effect of "being there" as presence [8].
- Identification - Empathy with or feeling as if one is a character in a narrative [13]. Emotional engagement.
- Flow - Complete focus on an activity to the extent that an individual experiences a loss of conscious awareness of oneself and their surroundings [49, 55].

Research has demonstrated that these constructs can somewhat explain how people tend to engage with narrative systems, however, it is acknowledged that these terms lack rigorous definitions and there may be unintended overlap or false

causal factors of what makes narrative elements engaging as a result [11].

That is not to say narrative elements do not motivate people to engage with a system. There is extensive research in this field [11, 44] and substantial conclusions have been drawn about the positive effects of narratives on engagement [11, 38].

#### 4.1 Narratives Elements in Gaming

Narrative elements are important parts of what constitutes a game. The ability to engage [11], transport [8, 18] and draw emotion [13] out of a game player contributes massively to said player's sense of enjoyment and satisfaction while playing [10, 18, 21].

Furthermore, narrative elements in games contribute heavily to shaping the game world and environment [10]. Research indicates that in-game storytelling is an effective tool to create a rich, engaging and meaningful gaming context [42] which leads to a heightened sense of immersion and player experience of need satisfaction [10].

Once again, the fact that 'what makes a game a game' is so varied and loosely defined means that little conclusive research has been published on the specific effects of narrative and storytelling elements on player engagement within gaming [13, 34]. Many papers suggest there is a strong correlation [13, 42, 46], but few studies have been conclusive. One study, Bormann et al. (2015) [10], conducted a test on 112 participants, split into three control groups (story, ignore story and a neutral group). These groups were put through different gamed-based experiences, with the 'story group' playing a narrative-heavy game, the 'ignore story group' playing the same game but being told to ignore narrative elements and the 'neutral group' being given a game with no narrative at all. All groups played for 20 minutes and were then assessed on their 'player experience of needs satisfaction' (PENS) and degree of immersion (both of which have a positive relationship with player engagement [8, 18, 21]). The study concluded that narrative elements in games significantly increased both immersion and PENS and therefore, assumably, engagement, although this was not explicitly tested.

One crucial distinction between narratives in gaming and narratives in other forms of media is the fact that a person playing a given game is not only being told a story, but they are an active participant in shaping the construction and outcome of the narrative [43]. This means that as a character in a game, a person must actively engage with the game in order to achieve a desirable narrative outcome. Salen & Zimmerman (2004) [45], found that other elements of gaming (goals, conflict) interact with narrative elements and, with the player as a character, result in a greater degree of narrative comprehension and immersion.

#### 4.2 Narrative Elements in Education and Game-based Learning

Storytelling and learning are closely linked, and have been since modern humans first started to communicate, roughly 30'000 years ago [29]. It was, and still is, leveraged to instill important lessons and to preserve traditions and knowledge [29]. In a higher educational context, the introduction of storytelling has been shown to increase student inquiry and reflection [3, 4]. McKillop & Chris (2005) [26] found that stories, when used as educational tools in higher education, encouraged students to delve deeper into their coursework and prompted reflection and critical analysis about said coursework.

Alongside this, Narrative elements are already littered throughout pedagogy [4, 35]. For example, story sums in maths classrooms are a manner of leveraging the ability of narratives to tie associated elements together and link them in a grander thematic context [18, 43]. This results in students garnering not only a deeper understanding of the coursework, but also a deeper understanding of the greater scheme into which the coursework fits [35].

Storytelling in a higher educational environment also accommodates for different students learning styles and has been shown to help students that do not respond to conventional pedagogical approaches [27]. This is due to the fact that narratives are a malleable form of knowledge acquisition and they can offer a holistic overview of the subject matter being taught [4]. This allows learners to have more of a say in the process by which they learn [4].

The effect of narrative elements in a game-based learning system have not been extensively, or precisely researched. This is due, in part, to the fact that game-based systems are composed of multiple elements and subject to wide variation [19, 22, 57]. Alongside this, narrative elements are an often overlooked aspect of gaming, as other popular forms of media (film, print, etc.) utilize narrative elements in a more obvious way [43] and are therefore a more popular medium of study when looking at the effects of storytelling on introductory programming, or more broadly, education [35].

One paper, Jabbar et al. (2015) [1] concluded that factors that keep students engaged in game-based learning are related to how emotionally invested a student was in the Game-based learning environment. This is of great importance, as narrative elements in gaming have been reported to greatly increase emotional investment in a game. More-so than any other element of gaming [13]. This information hints that narrative elements may be a useful tool in a game-based learning context to encourage student engagement with the coursework.



## 5 CONCLUSIONS

Game-based learning systems have been incorporated into introductory programming courses in recent years to mixed success. These mostly positive, but ultimately mixed results of game-based learning as a pedagogical tool for introductory programming are recognized to stem from the fact that games as systems vary too wildly and are too loosely defined to be able to conduct relevant research on the effect of gaming in general on introductory programming. The literature indicates that we should rather slim down the scope of our research to incorporate specific elements of gaming in a game-based learning context [57].

Furthermore, game-based learning solutions have been shown to work best when they operate hand-in-hand with other common pedagogical practices [22, 34]. This literature review has identified that narrative elements would potentially work well in a game-based learning system then, as storytelling and narration have been used in both education and gaming to link related concepts together into one, overarching thematic context [35]. This could allow students to more readily associate knowledge gained within the context of a game-based learning solution with knowledge gained in a similar sphere, but with a different pedagogical approach. Alongside this, we've seen that students struggle to stay motivated and engaged in introductory programming courses [52, 53] and that game-based learning has been leveraged to mixed success as a means of getting students to engage with introductory programming coursework [2].

Therefore, narrative elements are well-suited to a game-based learning context as they are specific, well suited to both gaming and learning and they may have the ability to contextualize knowledge gained within a game-based learning system with concepts and knowledge introduced in another fashion. Finally, there is a gap in the research here as very few studies have looked into the effect of narrative elements as a pedagogical tool to enhance student engagement in a game-based introductory programming context, even though this line of research has the potential to yield useful results.

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