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The Effect of Gamification and Narrative on Learner Engagement and Academic Achievement in Primary Schools: A South African Case Study

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ABSTRACT

As the major aims of primary school education are to foster both learning and enjoyment of learning, the main goal of this research project is to identify whether the use of storytelling can improve gamification of learning through a Learning Management System (LMS). Gamification is a known method for enhancing the enjoyment of learning as well as the reinforcement of learning, in tasks that are typically seen as routine or mundane. The study used a sample of grade 7 learners from a South African private school, using the national curriculum policy document as a content guideline. The study used comparative groups of two gamified learning management systems, with one system using the storyline of "Mission to Mars", where learners embarked on a fictional journey to Mars in search of habitable land. The other group used a similar learning management system, using generic images and discourse without using a narrative. Using game mechanics, which are common features used to structure games, the content was presented as a progression-based game to achieve the end goal of colonising Mars. Progression was based on learner participation in core activities that were required by the core curriculum and which were formally assessed, in temporal activities that occurred at different stages in time and in discretionary activities that were optional and were known not to be formally assessed. We found that the gamified systems were successful in reinforcing learning and were enjoyed by both experimental groups. It was anticipated that the use of a narrative, in conjunction with the gamified learning management system, would yield higher academic results and be more enjoyable, which was in line with research on the use of storytelling in education.

Contradictory data was found, which suggests that the use of narrative should be carefully implemented, as storytelling may only be effective if presented to learners in a meaningful and relevant way. The system was developed using a free web page designer, provided by Google, which would have limited the possibilities for developing interactive or customised teaching resources for the facilitator to use. This was found to be the main limitation for the study and should influence further research in this field.

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1 INTRODUCTION

1.1 CONTEXT

One of the aims of primary school education is to foster an enjoyment of learning while transmitting both skills and knowledge. Allied to this, is providing reinforcement of what has been learnt. Educators constantly seek ways to maximise learner engagement while using effective teaching pedagogy.

As learners are increasingly exposed to game-based systems, particularly on mobile devices, the appeal of these systems is apparent. There is a need to engage learners in a medium to which they are already exposed[1]. Being able to harness these gamified systems in the form of a Learning Management System (defined in paragraph 2.1 below) would, therefore, help educators meet these two objectives of primary school education.

Learning Management Systems are tools, such as websites or software applications, that help present course curricula[1]. These systems help monitor learner progress while allowing the students the freedom to access the curricula while at home, as well as at school. It is, therefore, necessary to ensure that a Learning Management System (subsequently referred to as LMS) not only facilitates learning but can help the student engage with the work and facilitate an interest in the material.

One result of using LMS tools is the development of Gamification in learning, which refers to the use of game characteristics in non-game situations to increase engagement [2]. Gamification is used to improve enjoyment in activities that would otherwise be boring or monotonous. It is also often used as a tool to help encourage or promote particular healthy behaviours[3]. Since many children already spend many hours playing video games this would be a good medium to incorporate into the learning process.

1.2 Research Problem

Educators need to be able to use technology to deliver curricula effectively, while keeping students engaged with the content. Learning management systems may be able to assist in nearly all aspects of an educators' responsibilities. Most functions for learning management systems also have generic names and are modelled after typical classroom processes. For example, academic task pages are typically labelled as assignments and social interfaces for asking questions and interacting with facilitators are typically labelled as chat or discussion. Even though this does provide clarity, there may be potential to alter the language to add to the theme of the program. An example of this may be that, instead of using the word assignment to describe an academic task, a space themed project could use the words mission or expedition as these are associated with what a stereotypical astronaut would do.

Even though there are a number of ways that are known to both improve engagement and academic results, this study will use an information technology approach due to the perceived increase in need for integration of technology in education [4]. As suggested by Culp, Honey and Mandinach, in a review of modern technology integration policies, there is a need to understand the nature of education technology integration [5]. The paper outlines, that modern research suggests it is important to integrate computer technology into modern learning, to the degree that national policy should account for this. This incorporates the need for research that provides insight into the benefits of modern computing and technology to assist educators and students [5]. As technology advances, educators should acknowledge the need for further refinement of education technology integration procedures. This can also be used to address how technology is then developed for important aspects in the field of education. There is also an increase in usage of technology in both poorly and well-resourced schools, as technology is a useful way of addressing concrete challenges that schools face.

A national study by Gentile [6] assessed the pathological video game use of 8 to 18 year olds. The study's initial findings showed that over 88% of its sample played video games. Most gamers played between three to four times per week and were predominantly boys. Clearly, many children are playing video games frequently. A negative finding from the study was that 8,5% of the sample showed pathological video game behaviour, where video game use was excessive or potentially harmful. This also shows that video games can be addictive, as the mechanics used to make them enjoyable, are very effective. The use of video games in education is, therefore, a good way of

keeping learners on task in class, due to their enjoyable nature. The compelling and absorbing features of video games can be used to aid learning.

The incorporation of a storyline often provides meaning in games, whereby goals are set for the player (or learner in this case) to progress within the story. At a primary school level, storytelling or the use of narrative is an engaging way of teaching morals or learning lessons [7]. Stories can be used as simulations of real-life experiences with either literal or metaphorical lessons behind them. This would allow the learners to experience scenarios that they would not otherwise encounter. Having a narrative provide direction for progression through a gamified system should potentially make the system more enjoyable and authentic.

1.2.1 Hypothesis:

1.2.1.1 The use of a narrative-based gamified LMS is more beneficial to primary school learners than a non- narrative-based gamified LMS in terms of learner engagement, academic performance and additional or discretionary learning.

To test this hypothesis, a simple form of a learning management system would need to be developed, which will rely on the dynamic functionality of external online resources as a support structure. The learning management system would have to incorporate the learning content as well as assessment criteria. To be able to differentiate the groups in relation to the use of narrative, there would need to be two distinct learning management systems that use the same general gamification mechanics. One of these systems would, however, use a storyline to progress the learner through the content. This system would use a theme to tie the gamified system and learning content to the narrative of the story. The second group would only receive a gamified system, with a generic theme unrelated to the course content.

To be able to identify whether a narrative is beneficial, this statement can be broken down into three smaller hypotheses. Each of the following hypotheses focuses on an aspect of effective gamification with further elaboration in the literature review.

1.2.1.2 The use of a narrative-based gamified LMS is more engaging to primary school learners than a non-narrative based gamified LMS.

To test for this hypothesis, each group's attitude towards their respective system will be rated at different stages during and after the running of their respective program.

1.2.1.3 The use of a narrative-based gamified LMS leads to better academic performance for primary school learners than using a non-narrative-based gamified LMS.

To test for this hypothesis, each group's average academic performance on the formal tests will be compared. Groups that tend to score higher on the formal academic tests may be shown to have benefited more from the learning management system. Learners' previous academic results can be used as a baseline from which to compare their academic performance.

1.2.1.4 Primary school learners are more likely to engage in discretionary learning experiences on a gamified LMS than on a non-gamified learning curriculum.

To test for this hypothesis, each group will be given supplementary activities to complete in conjunction with the core program. Each group will know that these activities will not to count towards their formal assessment mark and will be seen purely as extension work. Groups that tend to complete more of these discretionary activities may be seen to be motivated to seek extra stimulation. The groups that had received the gamified systems will be compared to the control group as to whether or not they would participate more in discretionary tasks, as a percentage of the class having completed an extra assignment.

1.3 THESIS STRUCTURE

The thesis aims to describe the processes required in designing and implementing a Learning Management System, incorporating both Game Mechanics and Theories of Learning. The thesis will focus on the following aspects:

The Background chapter will focus on the main concepts of the use of technology in education and gamification and why they are relevant for research. From this, it is necessary to identify any previous work on the use of narrative, game mechanics and technology in education. The Experiment Design chapter will use factors identified in the background and previous work, to set up an effective and relevant experimental design.

The Analysis chapter will describe the results of the study which was drawn from in the discussion. In conclusion, these observations will be used to test the study's hypothesis.

2 BACKGROUND

As the research problem identifies the use of technology in education as an effective tool for transmitting course curricula, it is necessary to describe the current trends in e-learning. As learning management systems are used as a medium for organising e-learning systems, it is important to define what they are.

Game based learning is not a form of e-learning but a pedagogical approach to teaching and education. It is important to understand how games are structured and what these teaching methods entail when incorporating game mechanics. The main goal of using games in education is to promote engagement in the learning process. It is, therefore, important to define concepts like engagement and motivation and how they can be incorporated into the classroom. This will be covered in chapter 2.5.

2.1 LEARNING MANAGEMENT SYSTEMS

Learning management systems (LMS) are used to help facilitate learning through the integration of both academic and administrative processes [8]. A learning management system's organisational functions are to record various student information, manipulate and store data. In support of the educational purpose of learning management systems, they are used to provide meaningful feedback to students, present course material and assess learners using computer-based assessment. The system is also used to communicate with stakeholders and allow general administrative duties to be performed electronically as well. Data is often stored in a way that is easy to summarise and understand. Typically, learning management systems are adopted by larger educational institutions, like universities. There is the potential to harness the power of a learning management system on a smaller scale, for example, to improve the functioning of a small primary school class.

A major factor influencing the success of a learning management system is the task-technology fit. This entails defining the task that is required of the system and how well the system is suited to help users complete their tasks. A study by McGill and Klobas [8] indicates that the persistent use of a learning management system can lead to an increased perception that the participant is learning, which is important for motivation[8]. There is, therefore, a need to identify what the learner requires, and whether an LMS can meet that need. In an educational context, this might involve helping provide extra content or be more interactive.

Social media sites are often used as a free alternative for managing groups of learners. As an example, Facebook is seen to have potential as a way of managing students, relationships and academics through the use of social media groups[9]. Facebook is one of the most popular social media platforms and it allows teachers to create media groups within which students can communicate. Facebook was not designed to be a learning management system, but a study by Wang et al[9], shows that a social media platform can provide a teacher with an easy alternate to purchased learning management systems. Issues arose when students felt uncomfortable using a private social media platform to participate in academic activities, which seemed to affect older learners more than younger ones.

2.2 E-LEARNING

This section on E-Learning is a concept that lends itself to multiple different practices, so it is useful to explain the layout of this sub-chapter. I will define e-learning and relate it to how it is used in practice:

- by teachers and students in the classroom (Blended learning)
- by teachers and students via correspondence (Distance learning and Massive Online Open Courses)

This should set up one's understanding of how e-learning courses are set up, in order to incorporate game mechanics in game-based learning, covered in chapter 2.3.2.

E-Learning is a broad topic with definitions ranging from the use of computers, use of internet or use of mobile devices to access learning resources [10]. The term "personalised learning" is suggested as a better definition of e-learning, as learning material is customised for the user's interests and abilities, which ties to the broad access one would have to information and activities on the internet [10]. E-Learning is also usually accompanied by the development of a learning itinerary, which describes the way that learning material is structured and presented to the individual in a sequence that makes sense. This relates closely to the focus of this research project, as it is the learning itinerary or sequence and presentation of the learning activities that is relevant. Game-based learning is the main aspect of e-learning that will be focused on here. From game-based learning, definitions and distinctions of serious games and gamification will be derived.

E-learning practice is often derived from research in traditional education. Bloom's taxonomy is one of the better known methods of classifying assessment[11]. For the relevance of using well known and commonly incorporated assessment techniques to help this research project assess the learner's academic ability, a simple interpretation of Bloom's taxonomy would be easy to incorporate. The revised Bloom's taxonomy is a way of classifying tasks of varying cognitive complexity[12]. Each classification incorporates a list of verbs that are often used to provoke thought. As Bloom's taxonomy is not a particularly modern classification system, later research has gone further to revise the model where the language, organisation and emphasis are updated. The model classifies tasks that require creating, evaluating and analysing as having the highest cognitive demand, which entails that deeper thought is required. Tasks that assess application, understanding and recall are seen as having the lowest cognitive demand. As the structure is hierarchical, learners would need to work through the least cognitive demanding tasks first, before they are capable of confidently attempting more demanding tasks.

Table 1 Table showing Blooms Revised Taxonomy and Structure of the Cognitive Process[12].

Structure of the Cognitive Process
Dimension of the Revised Taxonomy
1.0 **Remember – Retrieving relevant knowledge from long-term memory.**
1.1 **Recognising**
1.2 **Recalling**
2.0 **Understand – Determining the meaning of instructional messages, including oral, written, and graphic communication.**
2.1 **Interpreting**
2.2 Exemplifying
2.3 **Classifying**
2.4 **Summarising**
2.5 **Inferring**
2.6 **Comparing**
2.7 **Explaining**
3.0 **Apply – Carrying out or using a procedure in each situation.**
3.1 **Executing**
3.2 **Implementing**
4.0 **Analyse – Breaking material into its constituent parts and detecting how the parts relate to one another and to an overall structure or purpose.**
4.1 **Differentiating**
4.2 **Organising**
4.3 **Attributing**
5.0 **Evaluate – Making judgments based on criteria and standards.**
5.1 **Checking**
5.2 **Critiquing**
6.0 **Create – Putting elements together to form a novel, coherent whole or make an original product.**
6.1 **Generating**
6.2 **Planning**
6.3 **Producing**

Bloom's taxonomy can also be mapped to the way information is interpreted by computers[13]. Learners' competence in tasks that are not demanding can be equated to how a computer can recall basic information, like lists or bookmarks[13]. A more cognitively demanding task, like analysing data, can be compared to how metadata is tagged to online information. Tagging requires the user to understand and interpret the information correctly, in order to apply an appropriate tag[13]. Using Blooms' digital taxonomy shows how information is arranged digitally as a reflection of how information is processed by the individual. It is necessary to incorporate this into learning management systems, to help present and assess academic content appropriately.

2.2.1 Blended Learning

The approach of blended learning is also a popular term used to describe certain practices. Blended learning is characterised by the way it uses a range of media to deliver content curricula[14]. The concept acknowledges that there are many ways that people access and interact with information in education today. Being able to create a learning program that incorporates multiple media of instruction would be a more effective approach than choosing only one medium.

One of the main dimensions of blended learning is through the use of the internet, where learners can access content online in their own time, while also participating in traditional offline classroom settings[14]. Blended learning also incorporates design choices that are unique to self-directed learning. This includes determining how much of the program is to be guided by the learner or teacher. The teacher will also determine the curriculum's structure, whether it be restrictive or accommodating. As there are many commercial content packs for electronic devices on the market already, teachers can choose to incorporate these off-the-shelf packs or create their own content. These dimensions can be crafted into a program that can resemble a real work environment or simulate a real-world situation.

The National Institute of Information Technology (NIIT) in India has categorised blended learning into three models that compare blended learning activities with their traditional learning counterparts[15]. The first model describes a skill-driven approach to program development, where knowledge and skills are the explicit outcome, requiring regular feedback from an expert. The

second model describes the attitude-driven approach, where specific behaviours are modelled through peer interaction. The final model describes the competency approach, where effective job behaviours and knowledge are imparted through observation and analysis of experts. All three approaches acknowledge the importance of a mentor to help facilitate the learning process.

As this thesis focuses on a skills-driven approach, when using NIIT India's blended learning model, it is important to consider the tasks that incorporate a skills-driven program[15]. These programs tend to incorporate a learning management system, with integrated web tutorials, emails and an online repository of information. Messaging services, like email, are used to keep users informed of any changes within the learning system. This can include where learners should be within the system at any given time. The online repository can take the form of e-books, videos or simulations, where users can access the material at their own pace. Certification is usually assessed online as well and can be graded rapidly[15]. In contrast to this method, a traditional approach would require a traditional classroom environment for pacing[15]. A learner—teacher meeting would take the place regarding most feedback. Changes in the program are made as announcements during class sessions and are not as flexible. Any demonstrations or learning activities require the mentor teacher present, as facilitation cannot occur outside of the class session. This contrast in approach empowers the learners to complete work by themselves when they are feeling confident to do so.

2.2.2 Distance Learning

The Oxbridge Academy's online advertisement describing distance learning states that it is a form of learning where there is little to no face-to-face interaction [16]. Study material, assessments and support are all provided via a range of synchronous or asynchronous messaging or information systems [16]. The complete university guide online states that distance learning is a good way of creating a balance between home and work life, where the individual can set their own pace of study [17]. One negative aspect to distance learning is that learners may lack dedicated support and may feel isolated from their university. These issues are prevalent amongst distance learning courses.

Distance learning can be seen as a teaching strategy. When comparing the success of different teaching strategies, it is good to have a scale upon which to judge the effectiveness of an approach [18]. This scale tends to include student outcomes, student attitudes and student

satisfaction. When comparing distance learning to traditional teaching, there seems to be little difference between the two. Distance learning tends to produce similar grades to that of traditional teaching and produces students with similar attitudes towards learning. Early research does suggest that distance learners tend to be more satisfied with the course than traditional teaching [18]. Literature reviews of the actual empirical research also tend to have a few shortcomings that reduce the validity of current findings and there are also gaps in research. Thus, a lot more research is required to determine the effectiveness of distance learning and how technology can help improve their learning experiences. As part of the suggested learning management system proposed by this research project involves learners having access to the learning content from home, distance learning is acknowledged as a relevant teaching strategy.

2.2.3 Massive Online Open Courses (MOOC)

Massive Open Online Courses (MOOCs) are instruments where institutions can create free online classes that provide a quality educational experience. Unfortunately, MOOCs have a tendency to suffer from poor user engagement, as they require the user to be intrinsically motivated to participate regularly [19]. This could potentially be an area where gamification can be used to improve user engagement as there has been an increased focus on MOOC research to help identify ways in which they can be made more engaging. Studies often identify that there are three important interactions in maintaining a MOOC while providing engaging material, namely, the learner-content, learner-learner and learner-instructor interactions [19]. The learner to content interaction can be described as how a system incorporates self-expression, pattern recognition, and status and time pressures. The learner to instructor interaction governs goal setting, instruction and rewards, while the learner to learner interaction, governs reputation points, peer tutoring, competition, altruism, group identification and peer appraisal.

2.3 Game-based learning and Gamification

In order to understand the rationale for gamifying a system, this outline should help understand why games are being defined and used in this research project. This section will:

1. Define the social practice of playing games;
2. How games are used online to aid learning initiatives; and
3. The way that games are used to structure these learning initiatives in the form of gamification, including how game mechanics are integrated into these systems.

The chapter will conclude its focus by identifying what engages or motivates students, and whether this is a good fit for gamification.

2.3.1 What is a Game?

A game is a physical or mental competition administered by a framework and rules, which dictate what each player can do [20]. Games often have a central goal that its participants compete to achieve. Rules are often accepted for the sake of the activity being a game, suggesting that the players are more likely to participate even if there are some rules with which they may not agree. This would allow the game-maker to dictate what behaviours are deemed appropriate to achieve the goal of the game.

2.3.2 Game-based Learning

Game-based learning is seen as the use of games to achieve a learning outcome [21]. The gaming environment, which is created by the game designer, helps facilitate learning. Through play, users learn skills that will help them deal with real life situations [22]. The instructor will have to decide how to structure the use of games to integrate with curriculum design. Game-based learning is a broad concept, which is often grouped with related terms like , edutainment, gamification and Serious Games [23].

To understand the difference between game-based learning and gamification, one needs to understand how game-based learning is derived.

Serious Games are digital platforms that allow participants to experience real life simulations that wouldn't otherwise be possible[23]. Serious games often use computer graphics or real time images and data to create part of a simulation. Game-based learning is mainly characterised as a form of Serious Games that has defined outcomes[23]. For example, the serious game, "Code Combat" uses quest based role playing game mechanics to teach the basics of various coding languages[24]. The outcome here would be to be able to program simple scripts in various coding languages.

Game-based learning is different to serious games, in that it centers around learning, using games to assist[25]. Serious Games allow for more authentic and engaging learning experiences than learning from a textbook. Serious Games are categorised as games developed for learning purposes and not just for entertainment value alone[23]. Game-based learning is seen as an approach to learning while a Serious Game is seen as a tool.

2.3.3 Gamification

Gamification needs to be distinguished from game-based learning, as the design elements are fundamentally different. Gamification integrates some structural traits from how traditional games are designed and created, and uses them in non-game contexts[26]. Gamification can be a useful way of motivating users in achieving a goal that is otherwise mundane or boring. Motivation to use a particular system is typically dependent on the user's motivation to achieve a goal that is outside of the system[27]. The system becomes a mediating tool for achievement. Using a game-like interface provides an element of fun that can make the use of a system more interesting. Gamification is seen as a tool to help influence behaviour, as it uses game characteristics to encourage game-like player behaviour in real life situations[28].

The term gamification is also subjective, as one must consider the intention behind any gaming application or system[29]. Gamification is often facilitated by technology as a way of managing large amounts of information rapidly. The definition of gamification describes games as being made of interrelated mechanics, rather than a whole game-based system[26]. This means that games are created because of their rules or parts. To tie this to the subjective nature of gamification, this could entail a gamified learning program in a classroom involving only experience points, while a different gamified program uses only leaderboards for activities. The program is gamified if the users feel that they are a part of a game, not whether the program fits a framework for gamification.

Exergames are an example of gamification, where video games are used to make exercise more enjoyable[30]. The main goal of Exergames is to ensure that exercise related behaviours continue over time, even after the game has ended. Lyons (2015) suggests that gamification is a distraction from the real-world through the focus on the digital one. Players are inadvertently learning about their own behaviour, which is, therefore, modified and rewarded through in-game rewards. Using this premise, the design of a gamified learning system at a primary school level should try to draw the learner's attention away from being in a traditional class and redirect the focus to the fact they are playing a game.

2.3.4 Game Mechanics relating to Gamification

Games all contain a set of game mechanics which are seen as common features in the structure of all games[22]. This is not to say that all games must have an exhaustive game mechanic system to be

successful. Certain mechanics are used to achieve specific game-based goals. The proper use of game mechanics is important for the success of gamification[35].

Game mechanics, however, cannot be selected at random with any expectation of the resulting gamified learning management system being successful. They must include learning mechanics that are used to support the game mechanics[36]. The game should be a constant assessment of knowledge as the player progresses through the system. Mechanics should be identified for every possible game situation. This approach is seen as the Games and Learning Alliance's (GALA) attempt at mapping practices used to further a game's main goals, of entertainment and education, even though they are seen as one fluid experience[36].

Game mechanics are principles, rules and mechanisms that help to encourage behaviours. A mechanic can further be summarised as one part of the system of rules that governs one particular interaction within the game[37]. The game mechanic of a leaderboard is merely the creation of a list of participants, ranking them according to their performance over an activity or series of activities. As an example, the use of a leaderboard can be altered over the course of a week-long series of activities, whereby learners are motivated to achieve a placement on the top ten ranking of participants based on their participation. Any action or discussion based on the use of leaderboards would fall under the leaderboard game mechanic. Learning dynamics in video games are characterised by the temporal use of game mechanics that help to regulate the pace and engagement of learners[38]. These are used to assist the learner reach their learning goal. the incorporation of different game mechanics must be deliberate and appropriate for its purpose, as game mechanics do not entirely determine the success of gamification[35].

A few game mechanics that were relevant to the research project have been outlined below.

2.3.4.1 Leaderboards

Sicart outlines an example of the use of game mechanics through an object-oriented approach in video game design[37]. A mechanic is an event in the game world that evokes a reaction from the player. An avatar in a video game can only interact with an object based on the limitations of its environment or context. In a gamified system, a game mechanic promotes the user to interact with

the system given that the environment permits it[37]. Using the example of leaderboards as a game mechanic, users who feel that they can move up in the leaderboard will complete tasks that permit them extra credit in the hopes of influencing the leaderboard. Users cannot move up on the leaderboard if they participate in activities that are not relevant to the content set out by the system. For example, repeating a task that was fun but not necessary may be seen by the game designer as a waste of time, and they as a result may not in turn provide credit on the leaderboard for repeating tasks.

In a study by Landers and Landers , the use of leaderboards was used to test the effectiveness of gamified learning as a mediating process of learning[39]. The study suggested that learning outcomes are often reached by students who spend more time practicing what they have learnt. The use of leaderboards would be used to influence the amount of time users spend on individual tasks. Leaderboards were found to be effective in improving course performance after large or critical tasks. Leaderboards invoke a sense of challenge and competition, where progress is ranked against peers.

Goal setting theory is also important when providing students with leaderboards, as students need to be able to envision how they will compete with their peers[39]. This theory describes goals as specific, measurable, achievable, and realistic and time bound (SMART). When setting gamified learning tasks, learners should be able to make SMART goals that will provide the intrinsic motivation for participating. For example, in completing an activity on interpreting time zones, learners should be able to identify clearly what time conversion they must make, be able to assess how far and what knowledge they would need, determine whether the concept and mathematical formulas are understandable, identify whether it is possible to work out and identify whether they can complete the task before its deadline. A goal setting approach entails a number of steps be taken when developing an activity or mechanic like leaderboards[40]. The tasks should be described in terms of actions or behaviours to be taken. Performance measures should be created so that the participant may struggle yet be able to complete the task. The time span should be clearly described, and multiple goals should be organised in relation to their priority and temporal occurrence.

Leaderboards may also have a negative impact or no impact at all on mediating course performance. The competitive nature of leaderboards does influence social comparisons amongst

participants, however, if there are no clear awards for participating well, there may be little to no effect[41]. Awarding points may be useful in quantifying who is in better standing on a leaderboard, however, there should be a form of award for those who finish high up on the leaderboard. Participants who feel that it is competition for the sake of competing may have a negative attitude towards the mechanic. It is also not known how long leaderboards stay effective for, as there are few studies focusing on the use of the game mechanic over several months, whereas this project has only focused on a single month's worth of usage.

In order to facilitate achievement of challenging goals, the user will need feedback from the system to judge their performance[27]. Feedback in gamified systems can be provided in several ways and at different times throughout the game. Feedback can be provided instantaneously for instant gratification or can be provided intermittently to indicate a more significant advancement in a game's progression. Making use of visual feedback, like badges, or even auditory feedback, such as a triumphant sound effect, can have different effects on a learner's motivation or emotion[30]. Visual representations are an effective way of communicating progress and can be tailored to different learning styles[42]. An example of applying pressure to a gamer could be in the use of a health bar that depletes when something goes wrong. One could also apply a different form of feedback that encourages repetition despite failure such as a health bar that restores as correct answers are given. The use of feedback to provoke behaviours is, therefore, an important consideration in game design.

2.3.4.2 Badges

Badges are commonly used in gamification to signify and award accomplishment. Badges increase the visibility of a student's progress in a course without the use of a grade but rather a friendlier visual representation[43]. As badges are a decorative way of indicating progress. They support the gamification process and can aid other mediating game mechanics. Badges that are used effectively do not take away from the process of playing by overemphasising scoring points. The effective use of badges should be customised for the program, to reward desirable behaviours.

2.3.4.3 Feedback

In relation to the above research on the use of feedback in videogames, to keep learners feeling positive throughout the duration of the research project, feedback should not deplete a learner's progress or accumulated rewards but should build on what the learner already has. This may change the learner's perception of completing tasks from risking punishment to having an opportunity for a

reward. Providing visual cues of success, such as receiving a badge for successfully completing a task, can reduce the cognitive load on learners as to whether they have completed a task properly or not[30].

2.4 Game Design

In creating a game, such as physical or board games, one needs to incorporate a game design. Games inherently are associated with play[44]. For a game to be engaging, the user must find the game to be fun and should experience a form of play. For a game to be successful, it should incorporate meaning. Users should derive their meaning from how they interact with the game. This includes incorporating personal goals, interaction with other players and how the objects in the game are designed to interact with each other. A good game design incorporates how users make choices within the game. Being too restrictive or open ended may hamper a user's ability to make choices that are meaningful to them. Every choice a user makes should have an intended outcome. If users feel that their choices result in random or improbable outcomes, they may not feel empowered by their decisions[44].

Game design stems from the designer who is tasked with creating a context within which the players can interact[44]. Game design incorporates spaces, objects, narratives and behaviours. Therefore, in designing a gamified system in a schooling context, each of these elements must be defined:

- The space would be the learning context, being the use of classroom space, a learning management system and the class members.
- The objects would include anything the students must interact with, being the activities, game mechanics and each other.
- The narrative would be dependent on the learning outcome.
- The behaviours would be the way the learners need to interact with the system and each other to complete their academic tasks.

The clearer these elements are to the participants, the clearer the meaning that its participants can derive from the game[44]. Participants who can create a course of action to further the narrative by interacting with the system are more likely to have more meaningful and engaging experiences.

2.5 Theories of Engagement and Motivation

To understand how motivation and engagement are related to gamified systems, it is important to identify what engagement is and how it is often measured.

2.5.1 Engagement

Engagement can be linked quite closely to the success of a learning strategy or curriculum. Research shows that individuals are more likely to remain engaged in an activity if they enjoy what they are doing or find that it has value[45]. Elements relating to "gamified applications" often promote motivating factors for completing tasks like encouraging healthy competition or through external rewards like badges. The use of leaderboards seemed to be a very effective game design principle in short term studies or single session activities. Engagement was determined by a systematic review of current literature on gamification studies. Learner engagement incorporated the amount of time spent on the software, number of times it was accessed by a user, number of contributions made and the performance on the software[2]. Engagement seems to wear off over time, indicating that the novelty of these rewards is temporary.

As stated by Lyons[30], gamification can be seen as a distraction from the real world. Being engaged is related to being in a state of flow, where the feeling of engagement can occur on a spectrum. A flow state refers to the feeling of being completely immersed in a task, where most of one's mental resources are focused on said task[46]. This state tends to occur more frequently when engaged in work related activities and is argued to occur more during these activities than during leisure activities[46]. In a learning context, factors such as feedback, challenge and reward can contribute to the learners feeling of engagement. Learners tend to feel a sense of enjoyment when participating in challenges that, when completed, have provided sufficient satisfaction in relation to the effort made.

The five most engaging gamification mechanics of MOOCs suggest possible ways of enhancing the learning process[19]. These will be described below.

The first mechanic was instructors providing virtual goods as a reward for challenges. A description of this may be that users can earn experience points for completing tasks, which serve as a rating or mark. It can also take the form of users earning in game items that can later be used to affect how the game is played. The second mechanic was the ability to earn points that can be redeemed to

support their personal achievement. In-game shops or skill trees are examples of these where users exchange their points for in-game or real-life benefits. The third mechanic was using leaderboards for comparison and competition. Leaderboards, as described earlier, rank the users according to their performance. It serves as an explicit representation of who is winning the game. The fourth mechanic was having users discover hidden meanings within items in a MOOC. This could entail exploration within the MOOC to find extra rewards, which could add to the users overall score or provide a cosmetic item. The final mechanic was the collection of trophies and badges for achievement. This could be in the form of cosmetic images or announcements on a user's profile page that shows off the effort they may have put in.

2.5.2 Motivation

A characteristic of video games is that users are intrinsically motivated to participate in the game[47]. Intrinsic motivation entails how a user is motivated to meet goals that they have set for themselves, while extrinsic motivation entails how a user is motivated to meet a goal set for them[48]. Research suggests that strict control over activities reduces participant's sense of autonomy[47]. Self-determination theory suggests that learners need to be able to make meaningful choices through challenging tasks. Learners who feel that they can complete a challenging task within the given time, are more intrinsically motivated to keep trying[3]. Learners who feel connected to their peers are more likely to be motivated to participate. Self-determination theory suggests that there needs to be a balance of how much control students must have, to achieve success.

Gradecraft, an online gamification organisation, suggests that users should be given half of the points needed to achieve a good grade through assignments set to everyone and the other half of the points should be achieved through assignments that they can choose[29]. By being transparent with learners as to how they are graded as well as what paths they have to reach their learning goals, learners can make their own informed choices as to what work they will choose to complete and, therefore, be provided greater self-determination[47].

McCelland's theory of needs describes the intrinsic needs people have in order to show initiative in their work. This includes the need for achievement, for power and for affiliation[49]. An effective motivational system would find a way to incorporate a way to satisfy all three of these needs. The need for achievement can be described as the drive to succeed and do well. A good gamified system would, therefore, need to clearly identify the standards upon which students will be assessed and graded. The second need, being the need for power, broadly suggests that people inherently want to

make other people behave in ways that they usually would not. A good gamified system should have rules that allow the participant to affect other players. The final need, being the need for affiliation, describes the need for friendly relationships. A good gamified system would, therefore, require participation that encourages peers to cheer each other on, rather than only focus on competition.

Expectancy theory also describes motivation by linking behaviour to a desired outcome[50]. The theory describes how the expectation of a certain behaviour will bring about a certain outcome. The strength of the enacted behaviour is dependent on the strength of the expectation. Mediating factors are the attractiveness and perceived probability of a desired outcome. The individual's effort is more likely to result in a strong or weak performance based on their own perceived level of competency. This performance is expected to be linked to some form of reward. The reward should tie in to the individuals own personal goals and is thus evaluated as having been satisfied or not. Expectancy theory is often used to describe job satisfaction and identify why workers are performing poorly. Being able to apply this theory to a gamified system will entail acknowledging that the participants personal goals can be satisfied by the reward system of the game. The participant's effort should also result in related performance. If the game requires a lot of effort to output an average performance, participants may expect that they may not get the desired reward and will, therefore, be demotivated by the system.

2.5.3 Gamer Personalities and Engagement

Personality traits are strong predictors of how individuals will behave in a given situation[31]. The five factor model of personality, describes five main traits that determine an individual's behaviour being conscientiousness, extroversion, agreeableness, neuroticism and openness to experience[31]. As these traits are often used to predict human behaviour, it may be relevant to determine whether they could also determine an individual's behaviour in a video game setting. Therefore, it is important for program designers to consider the potential gaming personalities that will be playing their games, to harness individual's reasons for engaging in a game.

A study by Bartle on gamer personality types was used to determine whether gamers had unique personality types that would determine what they would find engaging in a game[32]. The personality types can be categorised as either Achievers, being players who play to win, Socialisers, who interact with other players, Explorers, who enjoy discovering secrets in games and Killers, who find it fun to impose their will on other players. Bartle felt that certain gamer personalities were

more likely to participate in different kinds of gaming behaviour. An engaging game should, therefore, provide each type of gaming personality opportunities to partake in activities that appeal to their unique personality type. Gamification should, therefore, cater for these personality types to maximise engagement.

The BrainHex project goes on to elaborate on Bartle's gamer personality theory, by collating a range of gamer personality studies to create seven gamer personality types[33]. The seeker personality, linked to Bartle's 'explorer' personality type, likes discovering new or unfamiliar things. Seekers tend to be curious in nature. The Survivor personality type enjoys escaping from threats, usually in tense situations. Survivors often knowingly get into scary or tense situations, after which they enjoy the feeling of safely escaping. The Daredevil personality type enjoys playing at speed or performing risky feats. Daredevils tend to be thrill seeking and risk taking. The Mastermind personality, linked to Bartle's Explorer personality type, enjoys solving problems and completing puzzles. Masterminds often devise efficient strategies for completing tasks that are meant to minimise work and maximise reward. The Conqueror personality, linked to the Killer-Achiever personality types, enjoys beating other players and difficult opponents. Conquerors are not opposed to struggling against a difficult player or game generated character, as their anger is often channeled to force their will on others. The Socialiser, similarly names and linked to Bartle's Socialiser, enjoys being a part of a group, helping others and interacting with other players. They often trust others and can become vengeful if trust is broken. The Achiever personality, also similarly named and linked to Bartle's Achiever, is concerned with collecting as much as possible and doing all quests available. They tend to be obsessive in their preoccupation with completing tasks and achieving impossible, distant goals.

Gamer personalities are described above by Bartle to have an influence over a player's motivation for playing video games[32]. It is, therefore, useful to incorporate aspects of what motivates each of these gamer personalities as elaborated by the Brainhex project to maximise engagement[34]. The Brainhex project also provides a short online questionnaire that is open to the public. Upon completion, the questionnaire records the user's video game playing behaviour and provides them a score on each of their gamer personalities. As this is an international scale project with significant findings relating to gamer personality research, our research project will incorporate the use of their online test to provide general information on the gamer personalities of our sample[34]. This will then be used to assist in the creation of the learning management system.

2.5.4 Role Play as a form of Engagement

Role play is defined as the act of imitating or mimicking the behaviour of someone, different to yourself[51]. Children often take part in this as a form of play. Role play is believed to increase the player's personal stake in a game, and more particularly, interest, in video games[7]. The use of storytelling and character development can give the role player a sense of immersion in the world created by the story teller. Role play requires its players to make meaningful choices, on which the storyteller will give feedback. Feedback gives the player a sense of interactivity, that their imitated behaviour is influencing the story.

2.5.5 Group Work

Traditional classes do not involve individual learners interacting purely with their teacher but have several learners who interact with each other as well as the teacher. There is a need to effectively describe how learners work in a group, as individual learning is not done in isolation from one's peers. Therefore, it is relevant to both describe simple group dynamics and show how they can be used or will affect the implementation of a gamified learning management system.

Muchinsky describes teams as being social entities bound within a larger community[61]. It is suggested that there are five main principles governing how teams should operate. A Team should provide feedback to its members and members should be willing to receive the given feedback. Teams require its members to support each other or be willing to help when needed. Effective teams view their interaction as the key to their group's success. Team members should be interdependent and require each other to complete team tasks. The final principle states that team leaders do make an impact on performance, provided that the leader shows appropriate behaviour for the given task.

The success of group work activities can be affected by a number of factors[62]. Group work needs to be mainly connected to real world situations. If learners do not feel that it would accomplish anything in the real world, they are less likely to engage in positive group work interactions. Group work must also be closely linked to course goals within the classroom. If a given concept is short and simple, the group work task should complement this. Longer tasks or more complicated tasks would be more appropriately suited to longer group work tasks. Groups should also be given sufficient time

to work on group tasks in class. Finally, peer evaluations can be used to identify learners who have not contributed to the given task. Allowing learners to identify that the potential failure of the group could be attributed to one member's negative behaviour will help buffer the group from becoming demotivated. Alternately, learners may not be wanting to cause conflict within their group and leave the underperforming members alone as a result. There may be potential here for further study.

Group work in a gamified system can be difficult to monitor, as group assessment encourages every member of a group to provide the same effort for different tasks. This would not be ideal as effort is calculated as an average for all of the group members[63]. Issues of unfairness or conflict could negatively affect the task. The "free rider" effect, where a group member contributes significantly less than the average input of its members and receives a disproportionate score for their actual effort[63]. Issues like these can be addressed through a number of techniques, for example, using peer appraisals or dividing up tasks prior to the problem being presented and provide scores relating to separate rubrics[63]. Specific rules and frameworks are needed to assist rewarding learners in a fair way for their contributions. As this would prove too difficult to assess in addition to marking individual work, group work will not be formally assessed in this research project.

3 PREVIOUS WORK

Previous work on blended or distance learning systems, that are typically run via online learning management systems, is important for understanding how to structure a new gamified system. This section used a systematic review as a source for finding literature, as well as identifying currently used learning management systems and how the literature supports their success.

Using a recent systematic review to initiate the research process for literature, it was evident that the use of gamification in education was effective in creating engaging courses[45]. The systematic review identified 15 studies from popular database platforms that used peer-reviewed study designs, particularly focusing on engagement in adult online education. Of the 15 studies, 12 yielded positive results[45].

Learning management systems, in their essence, are used to support the basic roles of an educator. An example of the effective use of an open-source learning management system is Moodle[52]. Moodle was designed to be customisable and can fit both very small and very large centers for education. The fact that it can be customised, shows that it could be used as part of a reward system that uses gamified techniques. This formed a start to my research on game-based learning as my literature review questions were based on how schools can use systems to help manage their educators teaching resources and learners electronic work portfolios in conjunction with implementing gamification [52].

3.1 GAME-BASED LEARNING AND LEARNING MANAGEMENT SYSTEMS

There is evidence that the use of game-based learning is an effective means of improving academic performance and engaging learners. A study on the use of four different video games teaching equation solving, showed an increase in academic performance and learner engagement[53]. Watch, Discover, Think and Act (WDTA) is an educational game-based program that has been used to successfully harness learner motivation to promote asthma self-management behaviours[54]. This is one among many programs that have been developed, incorporating both narrative and gamified mechanics to help motivate learners to participate in educational health promotions. Therefore, the use of game-based design elements in a learning system, could be even more beneficial for both teachers and students.

The use of narrative-based role play, particularly in fantasy, has been shown to positively influence learners feelings of engagement[55]. Storytelling using role play is known to improve learner engagement and enjoyment of tasks. Learners are also more motivated to take part in activities that would otherwise have been mundane if the feedback from their behaviour is likely to progress the storyline or provide them information on their own character's development. Squire's Quest also indicates the positive influence that narrative based activities can have on participants, as it used a medieval fantasy story where learners had to defeat the snakes and moles who were overtaking their kingdom[3]. To stop the invasion, learners had to take part in activities that incorporated learning about their daily food intake. The system was successful in changing the learner's dietary intake, this being the system's primary goal.

Video games often use cinematics as a way of progressing the storyline[55]. They are often short and are watched passively by the player. It is ultimately the player's behaviour in the game that drives the player through the storyline. Using the example of Squire's quest, explained previously, the learner's activity was directly linked to stopping the invasion of snakes[3]. This would not require a cinematic element, however, there is potential to improve the dramatic effect at the end of the program through its use. Interludes, such as the use of cinematics in Squire's quest, can be used to provided time for the narrative to be explored and provide purpose for the learner to interact with the system more.

The use of computers as a tool for creating and managing learning content has definite benefits to educational institutions[55]. The use of computers for embedding aspects of narrative or fantasy, that would otherwise have been more abstract through pure role play, may make the storytelling aspect of learning systems more immersive. This will serve as the main motivation for comparing the use of gamified learning management systems with a storyline against a simple gamified learning management system.

3.2 Narrative and Digital Media

Digital Storytelling, whether it is interactive or passive, are a way of using music, narrative, images and voice to direct students through a concept[56]. These are transmitted using digital media, which

makes them effective for large scale production and lowering costs. Authoring tools are used to structure the digital experience along with the use of educational pedagogies to assist knowledge building. Learners are even encouraged to use different media to construct their own stories and create their own narratives to suit the course content.

The PoliCultura initiative was intended as a tool to help teachers with poor information technology skills create their own presentations using the aspects of digital storytelling stated above[56]. The system allowed teachers to create digital stories that incorporate thematic music, images, videos and voice created by the teacher for their class. The initiative was a low-cost and simple system that anyone can use to create narrative-driven content. The completed narratives would be saved on the PoliCultura portal, where others are able to download and view them. This narrative-based system was seen to be quite positive in promoting knowledge transmission and motivation.

In-game awareness can also be improved through storytelling, as educational games are often not limited to just one medium. Pervasive games, where a game is assisted by real life activities, acknowledges that digital programs can be assisted through incorporating physical activities[57]. Pervasive games keep functioning even when players are not actively using the digital medium on which it is based. To ensure that learners do not forget that their real-life activities are linked to the game they are playing, a main storyline was developed. The difficulty with creating a narrative for this type of game is that real life events can be unpredictable. It was, therefore, necessary to create a broad storyline within which the game is to be played. An instance given was using a local news report as part of the overall story, while constantly linking real life events via messages to the students.

Digital storytelling and using narrative is also useful in reaching students who are accessing content in different languages[58]. Using images and videos, along with translations, these stories are more likely to engage these learners. This can also be applied to first language students who have difficulty with reading, as the content can be converted to audio to improve accessibility. The application, Microsoft Photostory, was used to provide evidence of the effectiveness of narrative driven projects. It is also suggested that the use of podcasts, as an alternative to written digital media, can improve a programs convenience and reusability.

Storytelling is often used as a basis or backbone for learning programs, as the program may seem out of place if just presented to the learners with little to no context[59]. An instance where a Virtual Reality game was used to support Mathematics instruction, testing the effectiveness of various

game dynamics, needed to use a storyline to drive the learners through the activities. The storyline was used to ensure that learners were gaining the appropriate skill at the appropriate time. The storyline was also stated to be authentic to real life situations. The storyline was kept simple, where the player had to walk into a sandwich shop and solve a few problems in deciding what sandwich to purchase.

The use of narrative in learning can also improve a sense of learner agency[60]. Agency refers to the learners feeling that they are in control of their own learning and decisions. A study by Lindgren supported the notion that using narratives and freedom of choice within a learning management system does improve engagement. Students had found that being given the choice of how to attempt the difference courses and activities available to them, aided their motivation to complete the required tasks at their own pace. The correct integration of agency and narrative can aid digital instruction.

3.3 Gamification in Health Science

Gamification is an effective method in transmitting a message or skill while reaching a large population and also being cost effective[64]. Being able to create real life physical and behavioural changes in the population has made the study of gamification prevalent in the fields of business, education and health studies. For example, in the field of health studies "Active Team" is an application that is used to link people via group-based gamification tasks to promote healthy behaviours like performing exercise. Initial studies from the use of this application have shown positive behaviour and attitude changes towards physical activity.

3.4 Existing Systems

A simple internet search for commercial or free gamified systems revealed many gamified applications. The gamified systems seemed to be tailored to either business training and motivation or school education.

Gamification systems that were tailored for businesses to influence employees' behaviour often allowed the business to customise a gamified interface with their own badges, tasks and rewards. Engagedly allowed unique customisation options for the business which also linked the system to real life aspects of the company which allow the managers to monitor their employees' activity[65]. Work tasks can be weighted and rewarded with a form of currency. Engagedly then allows users to

redeem this currency for gift cards. Managers also have the benefit of tracking which tasks are being completed.

Other systems such as SuMo and Spinify focused on encouraging sales, through using visual progress bars for sales goals and competitive sales activities[66][67]. GamEffective, a similar sales program, allows easy communication and feedback between managers and employees. The focus of GamEffective is to simplify and provide instant feedback on employee's unique performance targets[68]. These management systems provide employees a way of gauging what behaviours they need to display to be effective. Managers also have the benefit of creating activities or initiatives to promote sales.

Edgagement, a corporate information system for improving employee motivation, advertises that its system focuses on social interaction within the gamified system and encourages employees to manage and collaborate on tasks[69]. The application acknowledges that education and engagement are both critical for competing in an environment where a quick internet search can yield large amounts of product and brand information. The application also uses small learning modules, using both text and videos, to keep employees up to date on their product knowledge. Completing these tasks will reward the employee by adding credit to their online company profile. These credits are a representation of the employee's professional development.

Gamification-based systems used for education can focus on a wide group or on a narrow audience. Primary school-based classroom management systems, like the fantasy game Classcraft, allow the teacher to set activities, monitor behaviour, communicate with parents and learners and formally assess their class[70]. Any real-world interaction in the classroom can be translated into experience points, in-game rewards or currency for the learner to spend inside the fantasy game. A similar program, the role-playing fantasy game Prodigy, focuses on Mathematics education rather than on classroom behaviour[71]. In Prodigy, tasks are set by the teacher and are incorporated into the game environment as monsters to be defeated. For a user to successfully attack other monsters, they must successfully complete a Mathematics question. Teachers can monitor their classes progress via a digital mark book. Memrise is a language acquisition game that represents the player as an astronaut who needs to complete language activities in order to build and fly their spaceship into space[72]. Other programs on offer for primary schools are Tinycards, a game that aids learning via the use of flash cards[73].

Online learning platforms have also taken to the use of gamification to encourage participation in their online courses while offering the user immediate feedback on their course's completion. TedEd is a video based application that encourages the community to create educational videos that are supported by discussions and quizzes[74]. Users are rewarded for both contributing and completing courses. Khan Academy is a similar application that allows its users to choose from multiple different subjects to learn of varying degrees of difficulty to cater for learners ranging from primary school to tertiary education[75]. Coursera in contrast focuses on tertiary or adult education that links users to multiple Ivy-league accredited courses[76]. A popular program that offers a wide range of courses, however, focused only on Computer Science, is Sololearn. Sololearn offers users access to learn coding in a range of different coding languages[77]. Users are challenged after completing modules to complete challenges or compete in head-to-head activities with other users.

As most of the above-mentioned programs and applications have focused on education and business, Habitica is an example of a lifestyle based gamified application[78]. Habitica is a goal setting application that is set up by the user. The user would tell the application what their own goals are and what the steps would be to achieve those goals. Based on the amount of time, energy and stress the goals cause to be attained, the application will manage and notify the user when to do a goal-related activity. Users are rewarded for achieving their own goals, which rewards the user's profile with experience points and in-game currency.

3.5 Summary

There seems to be several initiatives and companies making use of gamification techniques, from business gamification practice for upskilling employees, health science education promotions to providing learning management tools in schools. These initiatives all use the same game mechanics outlined in chapter 2 in one form or another to improve a user's skill and knowledge development. The previous work and current programs on the market indicate that there is a demand for different ways of teaching students of varying ages. This is in relation to the push for initiatives as well as blended learning approaches in modern classrooms, as stated in chapters 2.2.1 and 2.2.2.

4 DESIGN

To investigate the influence of narrative on game-based learning management systems, the system requires careful design to harness the most effective design characteristics to maximise the system's performance. As the system created does not completely manage the learning interaction between teacher and learner, the system itself will be referred to as a learning system. The following aspects will be explained as to how they were incorporated into the program to improve the system's effectiveness.

- Learning management system design
- An appropriate software platform to fit the nature of primary school learning tasks
- Which game mechanics to incorporate
- Consideration of gamer personality types

As a basis for the above design considerations, an appropriate grade relevant curriculum is required.

4.1 CURRICULUM DESIGN

4.1.1 Learning content

The system implemented covers part of the South African-based Curriculum and Policy Statements (CAPS) curriculum outcomes for grade 6, Natural Science. CAPS is the South African governmental guideline for learning and teaching[79]. The policy statement provides information for teaching each official subject and protocols for assessment. It is aimed at outlining the basic skills and requirements teachers need to meet the minimum requirements for competence, on a national level.

As the current sample of grade 7's had not completed the CAPS curriculum in grade 6 due to the private school omitting the section to focus on other sections, the content would be relevant for inclusion in the research project. The content strand was related to "Planet Earth and Beyond" and the Technology strand "Systems and Control". Topics covered in the program include:

- The Sun, Planets and Asteroids
- The Moon
- Movement of the Earth and Planets
    - Rotation and Revolution of the Earth
    - Rotation and Revolution of the Moon

- Systems for observing outer space:
    - Telescopes
    - Satellites
- Systems to explore the moon:
    - Space Vehicles
    - Space Suits

Due to the time restriction of the fourth term within the school, the content was covered with outcomes being clear and concise. Continuous assessment was achieved through both an in-class activity and class test. A third test, given a few weeks after the post-test evaluated the retention of content. This formed a part of the learners' examination mark, assessed alongside other content areas that were not included in the learning management systems.

Thunderbolt kids served as the basis for the course content, as it is an open educational resource for South African government and private schools aimed at assisting the development of STEM (Science, Technology, Engineering and Mathematics)[80]. The content site was created to help develop an understanding of CAPS related topics, linking the intermediate phase (grades 4-6) to the senior phase (grades 7-9) and beyond. All course content is linked and accessible for free online, driven by the Department of Basic Education in South Africa. Workbooks were initially printed for free to Government schools in 2013, while they are not purchasable on the site for learners and schools. They have since been left for download via the web for South African primary school teachers. Teacher's guides are also available for curriculum planning as a part of the open educational resource initiative.

4.1.2 Experience and Ability points

Ability points are the game's currency for purchasing rewards, or upgrades. Ability points also referred to as Astro Points are gained for completing certain tasks, performing well on tests or just gaining a new level. These are tokens provided to players based on how often or how well they participate in activities[36]. They act as an incentive for participating in activities that are not critical for game progression or for exceeding expectations in critical tasks.

Experience points are the game's tokens for showing personal progression. Experience points are gained for participating in any task and can be purchased with ability points earned through other tasks. Experience points are also given based on extra participation or going above the basic

requirements for critical tasks but are not directly linked to academic performance. Instead of giving a percentage of the total experience points obtainable for a task, experience points are given based on ordinal levels of achievement. Table 2 shows the experience grading for marks achieved. Experience is used as a form of comparative currency, so that players can tell their relative position of participation to that of the class. Experience points are carefully explained to be partially separate from formal marks, so as not to embarrass academically weaker students. Students who achieve a particular grade in a test were grouped into categories and their experience points earned were added to their overall totals. The only way learners can find out how many experience points they had earned, would be to refer to the mark written on their test.

To the learner, experience and levels are proportionally awarded for effort they put in and not for what they achieve in tasks.

4.1.3 Academic tests

So as not to overwhelm learners with excessive testing, two short academic tests were formulated to assess learners' retention of basic concepts covered in each week. The first test covered the first two weeks content while the second test covered the final two weeks' worth of content.

Testing included the lower three tiers of Bloom's revised taxonomy, which focuses on recall, application and understanding[11]. Question types that assess a learner's ability to recall information include filling in the blanks, where learners must complete statements with the correct term. Short answer questions that assess a learner's application, required learners to write a statement in response to a question that requires the appropriate use of a recalled fact. Multiple choice questions were used to assess learners understanding, where learners must choose the true response to a question, while eliminating false answers. Learners should also be able to define the vocabulary used or elaborate on common abbreviations used, as a simple way of assessing whether learners have retained basic terminology. Marks achieved were mapped to a grade level, which would give them a different amount of experience points. Class tests were set out of a total of 25 marks, like that of learners' previous class tests, where half marks are permissible.

Table 2 Rewards of experience gained for achievement on formal tests

Mark achieved	Experience points gained
1-12	200XP
12,5 – 18	400XP
18,5 – 22	600XP
22,5 – 25	800XP

Individual tasks were based on typical worksheet type questionnaires, which learners had encountered throughout the year. Learners should be able to read through the week's content and answer application type questions based on said content. Learners were given either one-word answer or short answer questions, which would be recorded and graded via online forms. Task memos and feedback would instantly be emailed to learners once the teacher had assessed the form responses manually.

Two group tasks were given to help facilitate group affiliation. Groups were asked to design an informative poster or diorama of the solar system. Extra credit was given for creative, interactive and three-dimensional representations. The second task involved learners researching and formulating a booklet of constellations, pertaining to their personal star sign and another constellation of their choosing. Learners were marked individually but had to hand in their task as a group.

4.1.4 Extension activities

Extension activities were set to allow learners to obtain extra in-game currency, while covering topics not required in the core curriculum of the program. The aim of the extension activities was to encourage learners to engage with the topic, by learning new sections and doing so on their own initiative. Topics were not included in the CAPS curriculum and could be categorised as extension work. The topics included:

- Asteroids – the international space station and definition of asteroids.
- The Moon – the physical environment of the moon.
- Mars environment – Creative task, creating a Mars house applying knowledge of the physical environment of Mars.
- Space Ship design – Creative task, apply design principles to a model.
- Mechanics and basic laws of motion – an introduction to the basic laws of motion.
- First aid – treating minor and deep cuts.

Each extension activity had its own information that learners would have to read through as well as a relevant task or challenge. The tasks were not seen as formal assessment, which allowed variation in tasks as indications of creative work. Very basic rubrics were used to judge these tasks, to minimise the amount of marking required and to ensure that learners were rewarded for the time they put in.

4.1.5 Temporal Activities

Activities that occur at different times throughout the given implementation period, and that only last a few days to a week will be referred to as temporal activities. The temporal activities were made accessible from the newsfeed on each learning management system. The aim of these activities was to put pressure on learners to take part in beneficial activities and practice their problem-solving skills. The temporal activities were also not linked to the core curriculum, to promote learners engaging with curriculum outside of the necessity to pass the class test. The temporal activities were listed as follows:

Week 1's activity required learners to complete a short crossword. The first letter of each answer, when unscrambled, was a teacher's name. The first learner from each class to find that teacher would be awarded a prise of 20AP. The control group received the word search as an extra printout, without a time limit.

Week 2's activity required learners to practice a simple reaction test that was not academic in nature. It was tied into the narrative-based gamified LMS as astronaut training, rationalised as a way of ensuring astronauts have adequate reaction speed to deal with problems. Learners would then compete on the same device in class, on the same day, to achieve the fastest reaction time. The fastest reaction time, on average, would win 20AP.

Week 3's activity required learners to complete a visual and auditory puzzle. Learners were tasked with two codes, each code representing one part of an answer. The visual code required learners to decipher a letter code, where they would need to alter the alphabet to make a short sentence. The auditory code required learners to research the Nato-phonetic alphabet, to make sense of the

recording. The puzzle would require a learner to enter an event into a form for submission. Learners who were successful were granted 20 ability points. This puzzle allowed multiple learners to earn extra in-game currency.

The final activity required learners to decipher a date and research what happened on that date. The date was coded using binary. Learners who could figure out what numbers the binary stood for would find out that it was the date of a famous astronaut's death. Learners who guessed correctly would receive 20 ability points. The task was intended on being difficult in order push the learners who had been finding the tasks easy.

4.2 Learning System Design

The learning system is focused on a combination of face-to-face learning (F2F) and eLearning, as a way to improve engagement, accessibility and academic performance[81]. The system will present and manage the learning material required by the participating learners, while also assist the teacher who will need to monitor the learners' online behaviours and digital portfolios. The system was intended to provide a low cost and easy to develop alternative to buying or subscribing to an "out of the box" learning systems. The system was presented as a static website, using the integration of various word processing and database managing functionality offered by the Google App suite. Due to the limitations of the applications, as they were not intended for this purpose, the administrator will act as an agent to cause change within the system.

Groups were assigned one of two gamified LMS's. Group N (narrative gamified group) received the narrative-based gamified LMS while Group G (gamification only group) would receive only the gamified LMS. These groups were differentiated as follows:

Table 3 Table showing Independent variable LMS group design comparisons

	Sample	
	Group N	**Group G**
Group work	Subgroups were selected at random. An equal number of boys and girls were placed into each subgroup. Subgroups	Subgroups were selected at random. An equal number of boys and girls were placed into each subgroup. Subgroups

	were themed with space ship vehicles for travel to Mars. The unique story of the ship was dependent on the work of its members.	were themed with colours. Subgroups were intended to have no dependence on other elements within the game. Subgroups were not used as a comparative mechanism between the learners, nor were they used to further the progression through the game.
Leader board	The leaderboard was structured as a staff ranking, where learners were characterised as astronauts.	The leaderboard was merely a list of learners with the most amount of in-game currency.
Core Academic Activities	Activities were named, "Missions", with the requirement to complete tasks unique to each stage of the story. Activities were grouped into "parts", which were accompanied by a written story and video as a narrative device. Completing the missions was the main way of earning in-game currency.	Activities were named "assignments" as a theme neutral name. Assignments were unlocked in order, at the same time and in number as Group N. Completing the assignments was the main way of earning in-game currency.
Extension work	Extension work was provided in the form of "side missions" with the sole purpose of earning in-game currency. Extension work was unlocked with each part of the story, to serve as an extra way of earning in-game currency. These assignments were not recorded as a form of formal assessment but were intended to encourage doing extra work.	Extension work was provided in the form of extra assignments. These were provided as ways of earning in-game currency. These assignments were not recorded as a form of formal assessment but were to encourage doing extra work.
In-Game Currency	The in-game currency was posed as experience points, used as a way of gaging performance, and Astro-points, used to purchase rewards.	The in-game currency was posed as experience points, used as a way of gaging performance, and ability-points, used to purchase rewards.
Individual Progression	Experience points were used as an indication of how well the learner was doing in the section. As experience	As for Group G, there was no difference in individual progression.

	points were gained, learners would gain a level, along with a badge representing their level.	
Rewards	Rewards for good or extra work were given in the form of Astro-points. These points could be used by learners to purchase several upgrades for their profile. Upgrades were characterised by space-themed tools, which provided the learner with some form of class privilege.	Rewards for good or extra work were given in the form of ability-points. These points could be used by leaners to purchase several upgrades for their profile. Upgrades were given generic names, based on their category. Within each category, upgrades were given a number, as not to adhere to a theme. Learners had to research the reward number when they made their purchase.
Profile	Profiles were structured like a ship's staff. Learners were given the opportunity to choose a ship job and unique augment, which would characterise their identity in the game.	Profiles were given as a list of names within each group. Learners could customise their profile by choosing a nickname and giving their banner a background.
News board / feedback	The main information page with important game updates was called "mission control". Learners would be presented with a newsfeed, written as if events were happening in the game world. The feed was used to remind learners to read parts of the story or to keep up to date with missions.	The main information page with important game updates was called "news". The newsfeed was presented as a list of events. Updates or unlocked assignments would be posted on this page.
Work timeline	The pacing of the game was managed using Parts. As the story progressed, a new part would be unlocked. Each part was accompanied by a text story and video. The text and video were used to give meaning to the assignments unlocked during that week.	The pacing of the game was managed by unlocking two assignments and two extension assignments every week. Deadlines were structured to ensure that learners would hand in a previous week's work before the new assignment could be unlocked.

Temporal Tasks	Temporal tasks were presented as problems for individuals to solve, which would add to the narrative. Learners that solved the problem were rewarded with in-game currency and a news feed progressing the story based on learner's work would be released. Events only lasted a few days to pressure learners into completing them.	Temporal tasks were presented as challenges. Learners that solved the challenges were rewarded with in-game currency. Challenges only lasted a few days to pressure learners into completing them.

Group C, as the control group, did not receive any of the gamified systems. Instead, this group received a simple learning management system with identical content and assignments. The timeline remained the same as the two experimental groups, as assignments were given at the same time. The control did not include the in-game currency, temporal tasks, a newsfeed, leaderboard, badges or a profile. Marks were recorded on a typical mark book. Extension activities were also presented on the site in a similar way to the experimental groups, however, there was no reward for completing these tasks.

Table 4 Table showing the basic demographic composition of the samples

Class	Group Name	Boys	Girls
7H	Group N	10	7
7E	Group G	10	10
7C	Group C	10	10
Total		30	27
n		57	

Using the framework for designing a basic Learning Management System, as outlined by Ceiba as a reference for the transmission of the developed syllabus, there are a few functions that the Learning system should support[81]:

The main function should be to support the course syllabus. This was translated into the "Assignments" page or "Mission Control" pages for both the experimental and control groups. Each

web page will serve as a portal for learners to access the syllabus. The non-narrative-based group will receive the assignments as tabs that will periodically be unlocked for use. The narrative-based group will have assignments unlock as the narrative progresses. This group will also receive tabs relating to the narrative that will only be accessible once coursework is completed.

The coursework schedule is managed through temporal cues via the news pages. The news will be updated weekly and, on occasion, daily to suit the pace of the program and the learners. Learners will be required to check the newsfeed and enquire with their educator as to what work is available and when it will be due. A deadlines news feed will update according to the school's timetable.

The student sample was divided according to their register class, determined by the school. Classes were determined by balancing learners who socialise well together, are of varied academic abilities and who are known to have behavioural, psychological or attention problems. The classes will be described in further detail in section 6.2.1, however, it is relevant to note that three classes were used in the experiment and had belonged to the same grade. Each class was a grade 7 class with students ranging between 11 and 14 years of age, with the average age being 13 years of age.

Each class received a different learning management system, which is isolated from each other. Each learner within each class was given a small user profile. The profiles had been divided into groups at random, while still balancing the number of boys and girls in each group. Each group had its own minor goal that it will need to achieve, to receive a reward, encouraging cooperation within group tasks. This was provided in the form of the individual group's average experience level reaching level 6. Calculating the base amount of points needed to reach level 6, learners would have had to complete all core tasks and at least two discretionary tasks. The entire class also had a goal, achieved through all groups achieving by completing academic work. Inter group competition was encouraged, but there was nothing that inherently hinders groups from working together to achieve the class goal. To prevent the system from becoming too complicated, there was much less emphasis placed on group work, as individual work was the focus of the project.

The one design element that is often required by the school is the issuing of homework. The system is designed not to require learners to do work at home, but to offer them the choice to access the

work from home. In practice, we noticed that a lot of interaction with the system took place from home, as website analytics determined that students were interacting with both academic and non-academic pages after school hours. There seemed to be a relationship between the enjoyment score rated in the general survey at the end of each week. Some students were even accessing the web page during school time, in other subject periods, and after school. This can serve as an indicator of engagement, since students are using their personal time to access school content. Being able to measure when the site was accessed will indicate the extent to which learners had been encouraged to complete work at home as well as in class.

4.3 Narrative Design

The narrative was inspired by the MARS ONE initiative which aims to be the first organisation to settle the first people on Mars. The story was developed using the context of a dystopian Earth, where most of Earth's resources had been used up. The only hope for the survival of humanity would be to find a new planet to settle on. Fantasy elements were incorporated using custom space ships and encounters with alien life. The narrative intended to tie in elements from the core curriculum to authentically move the story along.

The weekly storyline was divided as follows.

1. Application to move to Mars – Learners were briefed on the disaster that Earth will be facing and have been given the opportunity to move to Mars. The missions required learners to learn about our solar system.
2. Navigating Mars – Learners were briefed that they had been launched into space. They will need to deal with problems aboard the space ship and preparing to navigate Mars.
3. Exploring Mars – Learners were briefed that a few key resources have gone missing and that the only way to find them is to explore the surface of Mars. Learners had to investigate the various space vehicles and previous moon expeditions, to understand their current situation better.

Depending on what the learner did during the project, each group would get a different narrative explaining the successes and failures of their participation in the project.

4.4 SOFTWARE PLATFORM

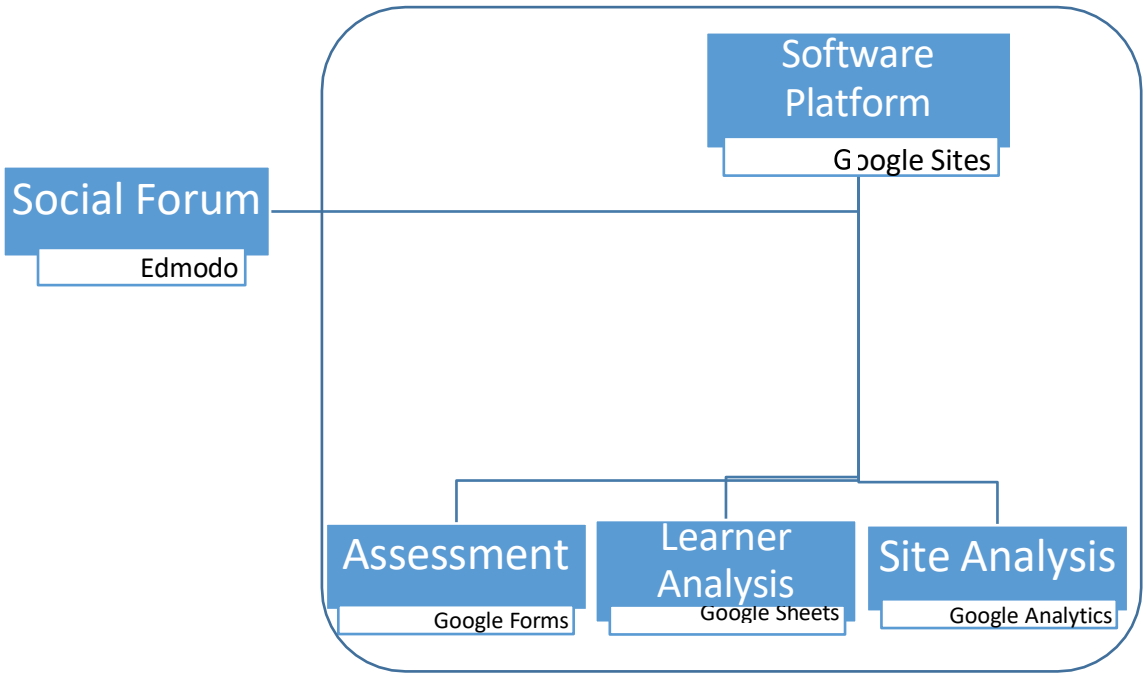

Figure 1 Diagram showing the relationship and hierarchy of the software used to create the LMS

Elements of the Google application suite are designed to integrate with each other, data collection process of using Google Forms an easy method of data collection during the project.

- Google Sites - Learning management system learner interface.
- Google Forms – Collect user assessment data, mark work and record raw academic marks.
- Google Sheets – Collate learner marks, summarise data and provide information for integrating with site.
- Google Analytics – Collecting learning management system usage statistics.
- Edmodo – Social platform where learners can communicate with each other and the facilitator

The learning management system was designed using Google Sites, which is a free web site design and hosting solution[82]. Google sites is designed to be versatile and adaptable. As the learning management system does not require advanced coding, it is instead suited to a spreadsheet-style mark book. Any behaviours enacted on the system can be quantified and recorded using Googles G-suite application called “Google Sheets”. The project includes a combination of both digital and pencil and paper activities so as to create a range of tasks within which to compare. Google Sites also offers the administrator easy access to update temporal tasks, newsfeeds and correct any errors that occur while running the system. Google sites is also optimised for a range of device

screen devices ensuring that learners can access the site on any device that they own. It is also not restricted to a specific operating system and works on a range of browsers. Google analytics is a plugin for user websites that simply tracks the usage data. There is no need to set up the analytics account other than to activate the analytics plugin when the project begins and deactivate it when the project ends.

Learners are able to access an online forum that permits them to communicate out of school time, while being securely moderated by the class administrator. Edmodo is a basic learning management system aimed at connecting learners through forums and providing other online resources[83]. Edmodo, as a learning management system, is a close reflection of the learning management system presented in this project. However, it does not permit customisability, which is what the project needed to do in order to provide a narrative. Edmodo does effectively allow and manage student interactions via an online, live forum. Learners can post questions, reply to peers, "like" comments, answer polls and post their own interest material for their respective classes. Teachers are also allowed to moderate these interactions to ensure that they abide by the school's code of conduct. Recent updates have also allowed teachers to post assignments and quizzes that are graded and stored in Edmodo's digital portfolio. Due to the technical constraints of the project and to ensure that all data is captured in a similar way, only the social forum of Edmodo is made available to learners.

4.5 Game Mechanics

The system incorporates both learning mechanics, derived from Blooms taxonomy, and game mechanics, outlined by Arnab et al.[36]. The following sub-sections outline the game mechanics used and their relevance.

As one of the main focuses of the system is the learner's academic performance, Bloom's taxonomy will be used as a basic indicator for tests that measure academic performance. As stated previously, Bloom's taxonomy classifies ways of thinking into a hierarchy, based on the cognitive demand on the learners[11]. This research project will only use the categories that measure the lowest cognitive demand, so as not to overly complicate the assessment procedure. This includes basic questions that assess basic recall, understanding of basic concepts and application of facts. Future larger research projects would be needed to focus on all categories of assessment that measure academic

performance on tasks that require varying degrees of cognitive resources.

Each of the game mechanics outlined in this section will be explained with a brief description as well as how they were integrated into the static website, created using the Google App Suite.

4.5.1 Leaderboards

The game mechanics utilised include the use of competition for high ranking positions[36]. These include (a) capture/elimination, which entails participants wanting to manipulate the position of other players on the leaderboard; (b) movement, indicating progression for high performing players; and (c) status, as a platform for players to show their success within the game. The learning mechanics utilised include the use of (a) planning, as players need to weight the value of tasks for progression up the leaderboard[36]; (b) incentive, as a reward for extra participation; (c) feedback, for players to see whether their extra participation is bearing fruit; and (d) motivation, as an intrinsic factor driving players to perform well on the leaderboard.

The leaderboard was implemented using a combination of Google Sheets, Google Forms and the charts function. As students interacted with the system, the administrator would use the marks accumulated from the worksheets and activities and enter them into the Google Sheets database. Google Forms is also able to link student's data with particular spreadsheets, effectively databasing the users input. The database would summarise the users' experience points and rank them. This can then be embedded into the website, in real time, using a chart.

4.5.2 Badges

In designing the program, it was difficult to imagine and list all the desirable behaviours, as learning is not always easy to monitor. This affected the design for the badges for the game, as during the implementation stage of the program, we found that new, ad hoc badges were needed, like for perseverance and special quest completion, which had not been planned for initially, which will be elaborated on in the discussion.

Badges are grouped according to outcomes which will be outlined as follows. To encourage learners to study and achieve well on the academic tests, silver and gold badges, which appear on their profile page as stars, are awarded for percentages achieved.

- Silver Assessment - Complete Mission 4 Over 80%
- Gold Assessment - Complete Mission 4 & 7 Over 80%

To encourage learners to complete both core tasks and extra credit tasks, the following badges are incorporated. The goal was for all learners is to obtain the main task badges, however, extra credit badges are earned for discretionary tasks.

- Part 1 Complete - Complete Tasks 1 and 2
- Part 2 Complete - Complete Tasks 3 and 4
- Part 3 Complete - Complete Tasks 5 and 6
- Final task Complete - Complete Task 7
- Beginner extra credit badge - Complete 2 extra credit tasks
- Intermediate extra credit badge - Complete 4 extra credit tasks
- Advanced extra credit badge - Complete all extra credit tasks

Badges are awarded for a range of different behaviours, with the goal of getting learners actively participating and engaging. If learners complete the core tasks only, they are only able to achieve a status of level 5 on their profile. Those learners that take part in other activities or engage in other aspects of the gaming system are able to achieve up to level 9 on their profile. Each level will award the learner with a different numbered badge.

The following badges are awarded for other non-academic behaviours. These are used to encourage learners to interact with each other and with temporal activities.

- Participator - 10 contributions on the forums. This would include creating a forum discussion and replying to discussions.
- Overpowered - Buy 8 upgrades. This would include trading in their ability points in the game store 8 times.
- Secret 1 - Cracked secret code 1. This would include completing one of the surprise tasks that will occur in the second week.
- Secret 2 - Cracked secret code 2. This would include completing one of the surprise tasks that will occur in the fourth week.
- Beaten up & Attacker Badges – The first player that uses the perk that can drain another player's ability points will receive the attacker badge, while the person who was attacked will receive the Beaten-up badge. These are considered offensive perks aimed at manipulating other players, potentially preventing them from buying perks themselves.

- Booster – If a learner were to trade in their ability points 5 times to receive more experience points without completing tasks, at the expense of real-world benefits, they will receive this badge.

The game mechanics used for badges should be mapped using the model on mapping mechanics in serious games. Competition is achieved as players can compete for unique or difficult to obtain badges[36]. Appointment is characterised as being able to differentiate players based on a title or status. Within the program, this would permit users to earn unique badges that can set them aside from other players. Tokens are used as an alternate to real life currency, entailing the use of experience or action points. These tokens, commonly referred to as "in-game currency", can be spent on perks or extra credit. Rewards are a way of incentivising learners to participate in as much of the learning management system as possible.

The learning mechanics used for badges would include, (a) ownership of their profile or online presence through decorating their page with badges earned[29]; (b) Action/task, as certain behaviours will reward players with badges; Discovery and exploration, as players who interact with the system in different or creative ways will be rewarded; and (c) Imitation, as players who desire a particular badge that another player might have, could imitate the required behaviour for said badge.

Badges were designed using a basic image editing program, MSPaint. These were then uploaded to the administrator's Google Drive account with relevant labels. As students earned badges, as outlined on the rubric on the Badges web page, the administrator could drop the images onto each learner's individual profile page.

4.5.3 Forums and in-class discussions

The main game mechanics that would apply to the use of forums include the use of infinite gameplay where users can interact as much as they desire without feeling limited due to the time of day or nature of their interaction[36]. As forums do not typically drive the game or narrative, they do aid in allowing the user to feel that they are still within the game when they are participating on the social forum. Questions and answers via the forum or in class discussions can assist players who need help understanding an activity. The forum can permit an element of role play, as users can interact with the system as a player rather than a learner.

The learning mechanics used in the incorporation of social forums includes being accountable as learning is driven purely by the amount of time and energy put into the system in response to the requirements of the task they are on[36]. A learner can collaborate on tasks, allowing players to combine their efforts to achieve a goal. Feedback is also constantly given to users who participate. Feedback in person is also important in a school context. Reflection and discussion on tasks allows players to learn from their mistakes or plan more efficient courses of action for future tasks.

4.5.4 Ability Points

Upgrades and game mechanics are each linked to one of BrainHex's gamer personality types[34]. Upgrades are purchasable with ability points, which help learners achieve any intrinsic goal they may have set, thus catering for all personality types. To understand how most of the personality types were incorporated into the project, experience and ability points as an in-game currency were used to facilitate interactions.

The following items or perks are available for purchase using the in-game currency of Astro Points or Ability points, earned through classwork. The relative cost of astro-points is attached as an appendix.

Individual Purchasable Items

- Hijack the newsfeed – Learners can write their own short article, and have it published on the newsfeed.
- Submit in any 1 locked side mission early
- Hand in assignment 3 days later than its due date
- Increase experience for side quest by 20 percent
- Play a video for the class
- Trade ability points for experience points.
- Deduct 10 ability points from every member in another group
- Learners can come to school in their informal clothes for a day. This perk was disguised as an unknown prize until the first player buys it, adding an element of risk.
- Remove a question from a test, altering the participants mark and test total.
- Create a poll for the class on Edmodo
- Complete challenge to prevent a perk and make it backfire. Affects certain perks.
- Choose from the prize pool

Group Purchasable Items

- All players in the group that owns the group upgrade will receive 10% more experience for missions.
- Creates an embarrassing badge that will appear on a groups profile page.
- All players whose ship owns the protect upgrade are immune to many of the negative perks that could slow player progress.

Table 5 Table showing the Brainhex Gamer Personalities and how they were tied into the LMS

BrainHex Gamer Personality Type	Game Mechanic	Purchasable Item or Perk
Seeker	• Storyline / narrative • Hidden codes and challenges • Unlockable Badges	• Play unlockable video for the class perk • 1-day civvies perk • Choose from the prize pool perk
Survivor	• Defensive upgrades	• Hand in assignment 3 days later than its due date • Complete challenge to prevent a perk and make it backfire to affect the attacking player. • Remove a question from a test, altering the participants mark and test total perk
Daredevil	• In-game currency gamble	• Mystery prize
Mastermind	• Hidden codes and challenges • Progress bars	• Submit in any 1 locked side mission early perk
Conqueror	• Ability points • Offensive upgrades • Leaderboard	• Deduct 10 ability points from every member in another group perk • Embarrassing badge perk

		• Complete challenge to prevent a perk and make it behave negatively perk
Socialiser	• Group tasks • Class forum • Defensive upgrades • Group upgrades	• Hijack the newsfeed perk • Create a poll for the class on Edmodo perk • Protect upgrade perk
Achiever	• Badges • Extra missions • Main missions • Experience points • Ability points • Leaderboard	• Increase experience for side quest perk • 500xp boost perk • Group upgrade perk

To ensure that learners are not only focused on the in-game currency, many other game mechanics were incorporated which will be explained below.

4.6 Assignments and Testing

Assignments, tests and temporal events were spaced out to help learners structure their time. Two assignments were made available per week, giving a one-week deadline for learners to complete them. Tests were scheduled at the end of the second week and the end of the fifth week, for learners to be exposed to sufficient content for testing. Temporal events were scheduled at the beginning of the second, third and fourth week and only lasted for one week. These assignments were not compulsory, however, and they provided benefits to learners who completed them.

The pre-test was explained to learners as a way of obtaining their interests to make the next section in Science more engaging. It was completed two weeks before the program started, giving enough time for learners to partially forget about what gamer personality and attitude scales they had been given. Attitude surveys were administered at the end of every week, except for the final week, in which the post-test attitude survey was taken. The post-test attitude survey was administered the

week after the program had concluded. Due to the timing of the post-test, not all the original sample were able to complete the test, as absenteeism was high during the final week before the school examinations. This may have affected the overall results. As the students who were unable to take the post-test were absent at random, this partially ameliorated the impact.

5 EXPERIMENT DESIGN

5.1 GAME PROGRAM

The following chapter outlines how the groups and tests were set up to begin the experiment. A series of pre-tests were run, the school's device policy was explained, and the tests were linked to the formal assessment policy of the school.

5.1.1 Pre-test – General Survey

The pre-test survey was used to determine the basic characteristics, access to technology suited to the study and general attitudes towards . The survey was intended to gather information to describe the sample, prior to the initial academic pre-test. Appendix A contains a summary of the form used to assess learners.

Aside from asking for consent, general characteristics such as name, gender and date of birth were required from participants. Access to technology was assessed by firstly recording whether learners owned or had access to either a phone, tablet or computer. Most of the sample had access to either an Apple-based phone or tablet, with many students also having access to Windows based laptops. None of the students claimed that they did not have access to some form of technology.

Secondly, learners were asked whether they or their parents have an email address that they can use. As learners often do not know their internet speed at home, they were asked the general speed of their internet on a 5-point Likert scale ranging from no internet to fast internet. Learners were also asked to record how much data they get per month, which would typically only apply to learners with phones or tablets, or whether they use their home network. A concern for the study was that roughly 7% of the sample did not have access to the internet or had very slow access.

The second part of the survey was used to determine how often the learners play games. A 5-point Likert scale was used to gauge attitudes towards statements regarding their game playing habits. By providing a continuum of either negative or positive reactions to a given statement, participants are best able to express their views[84]. The statements explored whether participants enjoy games, how often they play games, how often they socialise using technology and how often they use technology to research their own interests. Participants were also asked to provide an average time

spent playing games, in hours, every day. 48% of the learners stated that they spent a lot of time playing video games after school with 9% feeling undecided towards the statement. 60% of the learners stated that they use technology for social purposes and 58% stated they use it to research their own interests.

The third section was used to determine participant's attitudes towards . Participants were required to express their attitudes towards functions implemented in the learning management system, namely: presenting the curriculum as a game, being able to access the curriculum from home, being able to lookup deadlines from home, being able to socialise via Edmodo, being able to earn extra credit in class and how much the teacher should control the direction of coursework. The attitude ratings were very positive for all the above statements. Students seemed to have mixed opinions towards the statement, "using a website as an alternative to textbooks and worksheets," which might indicate they are unsure whether it is a good alternative. 30% of the students were undecided how they feel towards the statement, 30% felt negatively towards the statement while 40% felt positively towards using a website as an alternative.

Finally, their willingness to participate in using a website instead of using a textbook to learn a section in Natural Science was assessed. 68% of the sample were willing to try out the system, while the remainder of the sample were neutral.

Students also completed the BrainHex personality type survey, which asked the learners many questions relating to their video game and real-life behaviour[33]. Questions ranged from asking how participants would react in different situations, with responses having different point values relating to a gamer personality. Participants are also asked to rank a series of statements relating to how they would behave if they were playing a video game. The site then categorised them as one of the eight personality types, which was recorded at the end of the survey. Each learner's individual personality score was also recorded, as each personality was given a percentage rating. This would mean that even if a student was categorised as a daredevil, they may also have strong conqueror personality tendencies.

Table 4 shows the average student score for each of the gamer personalities assessed by the Brainhex Quiz. Both experimental groups seemed to score higher on items relating to the Achiever and Conqueror categories, while scoring lower on the Survivor and Daredevil categories.

Table 6 Table showing the samples' Brainhex personality scores

	Average score of students
Seeker	9.56
Survivor	6.1
Daredevil	8.44
Mastermind	10.24
Conqueror	11.58
Socialiser	8.8
Achiever	12.06

Every learner would be given a score out of 15 for how they rated according to each of the personality types. Table 4 shows the average score every student received for each personality type on the BrainHex gamer personality test.

The data showed that majority of the sample categorised themselves as achievers, masterminds or conquerors. These scores were used to adjust how many tasks there would be for each personality type. There would, therefore, need to be more tasks that satisfy achievers, masterminds and conquerors than there would for survivors, socialisers and daredevils. This entailed the incorporation of more extra credit tasks, opportunities to earn every possible reward and options to affect how other learners play the game. This may not be possible in future iterations of this type of project, as the adaptation of the project is reliant on the active involvement of the facilitator and communication with the designer or facilitator.

As a majority of the pre-test showed positive attitudes towards and presenting the section on Space as a game, this showed that the sample was keen to participate. To account for learners that were not keen or showed little interest, even though there were very few, physical notes had to be made to ensure the sample were not disadvantaged in formal assessments. A few questions were selected to be used again in the post-test to compare whether there was a change in attitude, after the learners had practical experience with using a learning management system.

5.1.2 Tutorial and BYOD Policy

Bring your own device policies entail setting out guidelines for learners permitting secure and appropriate use of mobile devices, such as phones, tablets and laptops, in a school setting[85]. As technology is becoming an important requirement of schools, it can be both costly and difficult to manage. By allowing students to bring their own devices, schools can focus more on maintaining the network infrastructure and academic curriculum.

Most different economic groups have access to mobile technology, where even owning low-end devices allows students to access academic resources[85]. There is no clear proof of this in a South African, or even local, context as there are many factors other than access to a device that could be complications for access to the web. Research ICT Africa's study on relative price for data versus cellular coverage and average line speed revealed that most South Africans would pay higher prices for better coverage and speed[86]. This creates a price divide as cheaper cellular companies with weaker coverage struggle to provide access to poorer communities. This prevents companies who offer cheaper data bundles from being competitive with companies with larger coverage. Students tend to be more engaged with school work, have better access to resources and benefit from the interactivity of learning apps. Classes that allow students to bring their devices into the classroom can benefit from further personalisation of the curriculum. Teachers have greater control over what teaching resources they can use, while also allowing students the freedom to learn in different ways.

Limitations to BYOD policies are also important to consider, as they can also work against students if not managed correctly. Applications may be model dependent, allowing access to some students with mobile devices and barring other student's due to compatibility issues. Schools also need to keep students safe, ensuring the networks are secure and that students are properly educated on how to use mobile devices appropriately in a work environment or at school.

Even though there is a debate as to whether a BYOD policy is useful in a primary school context, it will be used as an aid to keep the study in line with the chosen school's information technology policies. In creating a temporary BYOD policy, the policy will be limited to Natural Science and any other class that would be willing to allow students to use their devices.

A single session was held with students informing them of appropriate behaviours for using devices in class. The tutorial lesson included the use of Bowling Green High Schools BYOD policy as a template to creating a usable and tested set of rules[87]. This included:

- Students and guardians participating in the study will still need to adhere to the school's discipline policy and code of conduct regards to the use of mobile devices.
- The teacher has the choice to permit and control the use of devices.
- Devices must be on silent mode or turned off when not in use. Headphones may be used for listening to video.
- Devices may not be used during formal assessments.
- Students are not permitted to take photos or videos while on campus, unless otherwise permitted by the teacher.
- Devices may only be used to access online content relevant to the curriculum.
- Students are responsible for their own device and should be careful when accessing their device out of class time. The school cannot be accountable for damage to devices, as it was advised that devices be handed in if not in use.

As the policy above has been adapted from Bowling Green High School, students were also informed that they were only allowed to bring a single electronic device, limited to a mobile phone or tablet[87]. Laptops and multiple electronic devices were not permitted to ease any strain on the network. If students could not bring a device to school, a device was provided for them for the duration of the class depending on availability.

5.2 Timeline

The experiment took place using a quasi-static-group Pretest - Posttest Design, as subjects were not randomly assigned to groups[88]. As the grade had already been sorted in relation to learner's academic ability, it was not necessary to assign learners to groups. Instead, it was far more convenient to use the pre-existing classes. Classes were, therefore, merely assigned randomly to either one of the two experimental groups or the control group. This means that each class had an equal chance of being a part of the gamified comparative groups or being a part of the control group.

Classes were assigned to use the narrative gamified learning management system themed around the mission to Mars, the gamified only learning management system or the control group. A pre-test and post-test attitude survey was collected from all three groups to gauge their feelings towards

the use of technology and presenting work as a game. Pre-test academic data was taken from previous academic reports for the year, particularly in Natural Science, since this subject was the focus of the program.

5.2.1 Dependent variable

Class test marks were added together and calculated as a percentage of the total test mark achievable for both class tests. A t-test to determine the statistical significance between the academic performances of each group will be conducted in Chapter 7. The results will be compared to that of the mean academic performance of the control group, to see if the use of the gamified system's core design elements did improve academic performance.

To compare the level of engagement of learners, weekly surveys were completed by the learners of both groups. Each survey required learners to rank statements regarding their level of enjoyment, on a 5-point Likert scale. Questions were created in relation to what students would be doing in the program according to the main aims of the project. For instance, question 3.9 asks students how willing they would be to use a website to learn from in Natural Science. Web analytics were also collected recording the number of page views and session data for assignment pages as well as the average time of day the pages were viewed.

5.2.2 Time Frame

The program was run over the course of five weeks. Assignments, extra assignments, temporal tasks and tests were made available at different times so as not to overload the learners with work and to help drive the narrative in Group N's system. To ensure that the workload was similar for all groups, both Group G and the Control group only had access to assignments as they were released to Group N. All tasks had a rough deadline in relation to their release date, ranging from 1 week up to the conclusion date of the program. All tests had a duration of 40 minutes of class time.

Table 7 Table showing the time frame for each of the core, extra, temporal and formal assessments

Week	Academic Task						
	Core Assignment		**Extra Assignment**		**Temporal Task**		**Formal Assessment**
	No. made available	Duration (weeks)	No. made available	Duration (weeks)	No. made available	Duration (days)	Test
1	1	1	1	4			
	2	1	2	4			
2	3	1	3	3	1	4	
			4	3	2	4	Test 1
3	4	1	5	2	3	7	
	5	1	6	2			
4	6	1			4	7	
5							Test 2

5.3 GROUP SELECTION

5.3.1 Population

The study focuses on the academic performance and engagement of primary school learners. Due to a lack of availability of the full target population, inferences will be generalised from the accessible population, which is a Jewish private school in Johannesburg, South Africa. King David Victory Park not only focus on Jewish Education but maintains international standards of general education[89].

5.3.2 Sample

The grade 7 cohort was used as there was easy access to adapt their class timetables in Natural Science. Classes were chosen at random to be a part of each different group. Learners were instructed that they would be completing work on an online learning system based on their results in the pre-test based on their attitudes towards technology. This was used to allow learners to give their consent to participate in the study. Academic class averages were obtained from learner's previous report marks for Natural Science in all the prior work completed in grade 7.

To encourage learner buy in, gamification often incorporates genres to help redefine the activities in which learners will participate [90]. As learners are familiar with video games and board games, using a similar format to a genre of video or board game will help improve familiarity with the system. To assist in clarifying the priority of an activity, assigning a relevant name relative to the genre will help learners decipher what is important and what is not. An example of this may be to use the title of "mission" for a class activity. The use of a narrative genre to describe tasks differences between groups, stated below.

The test groups received a Learning Management System that incorporated the game mechanics outlined in section 5.4. The main differences between the groups was in how the information was presented via a theme and narrative. The narrative based LMS used the story of a “Mission to Mars”, whereby learners followed their journey of having to move from Earth to Mars.

Content pages used for academic exercises were structured to be identical across all three groups. Only the substitution of words like “assignment” for “mission”, were made between the experimental groups, to ensure the content was presented in the same way. Assignments were all structured in an identical way, to ensure that a change of wording or arrangement would not alter how learners answered the work.

5.3.3 Control Group

The control group was structured to use a learning management system without any use of gaming elements as stated previously. Learner work groups were presented as lists on the group page, with no connecting theme between them. Activities were presented as assignments that learners had to complete in class or at home. The deadlines, as per usual classwork, were the only motivation for learners to complete work in a timely manner. Extension assignments were provided for learners who liked to complete any extra work, if they had finished their work early. The control group was used to monitor what the grade was going through at the time of the program.

6 RESULTS

6.1 POST TEST RESULTS

6.1.1 Academic Results

Table 8 Table showing the average academic score for the formal class tests

		Group Academic Achievement	
		Previous Academic Results	**Results Recorded from Project**
Group N	**Mean**	57.18	66.35
	SD	9.76	17.18
	SEM	2.37	4.17
	N	17	17
Group G	**Mean**	75.59	74.25
	SD	11.93	15.45
	SEM	2.67	3.45
	N	20	20
Control	**Mean**	67.99	61.95
	SD	10.55	19.57
	SEM	2.36	4.38
	N	20	20

The Shapiro-Wilk test, using a right tailed normal distribution, was used to test the data sets to see whether they were normally distributed. All data sets were within the 95% critical value accepted range.

Table 9 One-way ANOVA comparing the effect of narrative in gamification on academic achievement

Result Details				
Source	**SS**	**df**	**MS**	**F**
Between-treatments	1549.3124	2	774.6562	2.53024
Within-treatments	16532.5824	54	306.1589	
Total	18081.8947	56		

A one-way ANOVA was conducted to compare the effect of the use of narrative in gamification and gamification only with the control group on academic performance. At a glance, between the narrative based and non-narrative based groups, it appears that the non-narrative based group outperformed the narrative based group in academic performance by 5.81%. An analysis of variance showed the effect of narrative in gamification on academic performance in the study did not yield significant results to prove that the mean of the narrative based score was from a different population mean at $p < 0.05$, $F(2.54) = 2.53024$, $p = 0.089046$. This statement contradicts the findings in the literature review, where typically gamification used to aid learning new skills or content tends to improve academic performance[91]. This could possibly be due to the novelty of using a new system for learning, nature of the content being learnt or even the difficulty of the formal assessments used. The structure of the project and experience of the facilitator, not being an expert in human computer interaction and web design. This may need further testing as to assess what factors may have affected the results.

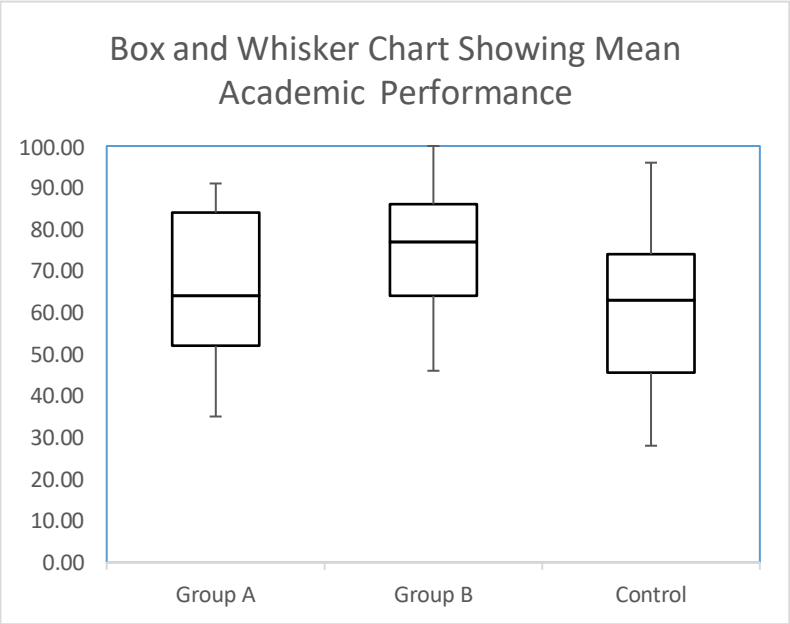

Figure 2 Box and Whisker chart showing Mean Academic Performance

Table 10 Table showing a paired samples t-test comparing previous academic performance with results from the LMS

	Paired Samples Test				
	Difference of the	**Std. Error Mean**	**t**	**df**	**Sig (1-tailed)**
	Mean				
Group N	-9.171	3.515	2.624027	16	0.009209
Group G	1.34	2.511	-0.898791	19	0.189729
Control	6.04	2.617	-2.289406	19	0.016838

The mean academic performance across the test groups were considerably higher than that of the control group, indicating that there may have been a base line improvement in academic performance. Figure 2 shows that as the medians for Group N and the Control group are quite similar while their marks are quite scattered around the median, while Group G's box is short indicating that participants performance are relatively in line with each other. In relation to learner's prior academic achievement, the average scores showed no definitive increase in academic performance at a glance.

A paired-samples t-test was conducted to compare academic performance between Group N's previous academic achievement on formal testing and their achievement in the project. There was significant improvement, where $p \leq 0.05$, from their prior academic achievement (M= 57.18, SD= 9.76) and their project achievement (M= 66.35, SD= 17.18) conditions; t (16) = 2.624027, p = 0.009209. A paired-samples t-test was conducted to compare academic performance between Group G's previous academic achievement on formal testing and their achievement in the project. There was no significant difference, where $p \leq 0.05$, between their prior academic achievement (M= 75.59, SD= 11.93) and their project achievement group (M= 74.25, SD= 15.45) conditions; t (19) = 1.729133, p = 0.100006. A paired-samples t-test was conducted to compare academic performance between the control group's previous academic achievement on formal testing and their achievement in the project. There was a significant decrease from their prior academic achievement (M= 67.99, SD= 10.55) and their project achievement (M= 61.95, SD= 19.57) conditions; t (19) = -2.289406, p = 0.016838.

The results suggested above might suggest that the use of a narrative in this study may have been somewhat effective, in conjunction with the use of its gamified mechanics[7]. The group that had received the narrative based system seemed to improve in academic performance, while the group without the narrative had no significant improvement. As the control group's academic results seemed to suffer, this may be because of having to adapt to a new medium for learning and keeping organised. The control group's negative performance may have come about because of not having the game mechanics to motivate them to engage with the system. This may lead to further questions, as to how to improve the use of learning management systems that are not gamified.

6.1.2 Discretionary tasks

Table 11 Table showing the percentage of each group successfully completing a discretionary task

	Week 1	Week 2	Week 3
Group N	**47%**	**29%**	**29%**
Group G	**55%**	**25%**	**30%**
Control	**40%**	**20%**	**15%**

Of the discretionary tasks provided each week, learners were able to submit the task before the end of the given week. Whether they were successful or not would depend on whether they had handed in the work on time and without missing any questions or parts of the activity. Table 11 shows the percentage of each group that had completed a discretionary task, that would have had no impact on their formal assessment. The data was too simple to test for the hypothesis, as whether they had completed the task or not would have been enough. This may not have counted for the quality of the submitted work.

6.1.3 Attitude surveys

The attitude surveys were created to assess the learner's enjoyment of the system at different stages of the program. The pre-test attitude survey was used to assess the learner's prior attitudes towards gamifying learning and using a LMS, as stated previously. The surveys were presented weekly on the site and a bonus was offered. Each survey presented the learner with a 5-point Likert scale, ranging from 1 measuring a negative attitude to 5 measuring a positive attitude. Learners were also presented with the option to comment on the week or give criticism on the system.

Due to subject mortality directly after having completed the program, averages were taken from the available learners from each class. The post-test asked students to rank the following statements on a 5-point Likert scale, where if they ranked 1 it meant they strongly disagreed with the statement and if they ranked 5 it meant they strongly agreed with the statement.

Table 11 shows the average score, rated by the learners in each class. Learners ranked their overall experience for each week on a 5-point Likert scale, ranging from 1 being strongly dislike to 5 being strongly like.

Table 12 Post-test Survey Summary

	Group Score out of 5			
Question	**Group A**	**Group B**	**Control**	**Mean**
1.1 The Storyline (the mission to Mars)	3.9			
1.2 The Groups themes (Space ships. jobs in space and space inventory)	4.4			
1.3 The space pictures. labels and colors.	4.2			
2.1 I found the assignments easy.	3.3	3.6	3.4	3.5
2.2 The content was difficult to understand.	2.6	4.4	2.6	3.2
2.3 The tests were easy.	3.2	4.6	3.2	3.7
2.4 I found it difficult to keep track of my work.	2.7	4.1	3.0	3.3
2.5 It was easier to study from the site than from my notes.	2.4	4.5	2.5	3.1
2.6 I always had access to the online notes.	4.0	2.9	3.9	3.6
3.1 The Leaderboard	4.1	3.3		3.7
3.2 The Experience Points	4.2	3.3		3.7
3.3 Astronaut Profile	4.4	3.3		3.8
3.4 The Astro Points	4.5	4.0		4.3
3.5 The Upgrades	4.3	4.3		4.3

3.6 The Story Videos	4.1	3.8		4.0
3.7 The use of Edmodo	3.1	3.7	2.5	3.1
3.8 The tutorial	3.4	3.9	3.3	3.5
3.9 Using Missions rather than Worksheets	3.6	4.3	2.7	3.5
3.10 The calendar for deadlines	4.4	4.3	3.6	4.1
3.11 The Newsfeed	4.7	4.5	3.8	4.3
3.12 The extra videos	3.7	3.4	3.9	3.7
3.13 The special events	3.9	3.9		3.9
3.14 The extra assignments	3.2	3.6	3.6	3.5
3.15 The extra games	3.9	4.1	4.1	4.0
3.16 The badges	4.1	3.2		3.6
4.1 I enjoyed playing the "Astro Quest" game.	4.6	3.1		3.9
4.2 It was easy to learn.	3.1	2.4	3.4	3.0
4.3 I liked working in a group	3.4	4.4	3.1	3.6
4.4 I didn't like the class Edmodo forum.	2.4	4.5	2.2	3.0
4.5 I liked the mission numbers as it helped keep track of where I was in the section.	4.2	3.2		3.7
4.6 I spent more time studying Science than before.	3.1	3.4	3.3	3.3
4.7 Learning should be presented like a board or video game.	3.6	3.6		3.6
4.8 I would prefer to study from a website rather than from a worksheet or from my workbook	2.7	4.4	3.2	3.4
4.9 I would like assignment deadlines to be available online at all times	3.5	4.6	4.9	4.3
4.10 I would like to be able to earn perks or upgrades on assignments and extra credit in class	4.3	4.1	4.3	4.2

4.11 I would prefer that the teacher decides what I have to learn	3.4	4.5	2.9	3.6
4.12 I would like to try again using a website to learn a section in Science.	4.0	2.9	3.8	3.6
4.13 It worked well on my electronic device	4.4	3.3	4.0	3.9
4.14 I mostly used my:	Phone: 90%	Phone: 81.25%	Phone: 68.75%	
	Tablet: 10%	Tablet: 6.25%	Tablet: 25%	
	Computer: 0%	Computer: 12,5%	Computer: 0,0625%	

Table 13 One-way ANOVA comparing the effect of gamification on learner enjoyment

Result Details				
Source	**SS**	**df**	**MS**	**F**
Between-treatments	0.3664	2	0.1832	0.25335
Within-treatments	40.4969	56	0.7232	
Total	40.8633	58		

A one-way ANOVA was conducted to compare the effect of the use of gamification on learner enjoyment via the weekly attitude surveys, using the post-test survey data. An analysis of variance showed the effect of gamification on learner enjoyment was not significant at $p < 0.05$, $F(2.56) = 0.25335$, $p = 0.777084$. The results did seem to be generally positive, however, no significant increase was drawn from the weekly surveys.

6.1.4 Analysis from Surveys - The Use of Narrative in a Gamified LMS

In general, the learners seemed to enjoy the use of narrative to drive the gamified LMS. On average, learners rated the story, the use of themes, the use of videos and the images very positively. The learners seemed to enjoy the group's summary page as a way of portraying their progress within the system, as this was rated the highest of the elements in the post-test.

6.1.4.1 The use of space themed elements

Items 1.1 – 1.3 were used to assess the narrative based group's enjoyment of the storyline related elements and how they were tied together using the theme of settling on Mars. As this section

focused on the use of narrative, Group G and the control group did not receive this in their post-test. In general, learners in Group N had a positive attitude towards all the narrative based elements, including the storyline and videos. Learners expressed enjoyment of the space themed elements, such as the space pictures, colours and space themed dialogue. A test of average inter item correlation for this section was 0.32, indicating that the items were reliable. It may have also been relevant to enquire with Group G as to what could have improved the look or feel of the site. If the group were to suggest that using more theme-based images or videos would have improved the site, this would be further evidence in support of the use of a theme. Follow-on studies should consider incorporating such a question.

Group N expressed that they may have liked to have more animated or interactive space-themed content, as the static pictures were nice but could have been improved on. This was a design limitation, as using a template-based website builder limited what could be incorporated into the final design. If this gamified system were to be built using a different medium, this is a design element worth including.

6.1.4.2 The structure of the course content

Items 2.1 – 2.6 were used to assess learner's attitudes towards how the work was presented on the learning management system. As this was relevant to all three groups, the post test was used to retrieve data from both the experimental and control groups. Students across all three groups seemed to feel that the assignments were slightly easier than what they were used to, however, their formal testing for these sections seemed in line with their typical academic performance. Most of the groups found that the content itself was easy to understand but was not significantly easier.

Table 14 One-way ANOVA comparing learner attitudes towards the LMS's ability to organise classwork

Result Details				
Source	**SS**	**df**	**MS**	**F**
Between-treatments	5.4863	2	2.7432	F = 1.89002
Within-treatments	300.4375	207	1.4514	
Total	305.9238	209		

An analysis of variance showed the effect of the learning management systems ability to organise classwork and keep learners up to date, in items 2.2 – 2.5 of the post-test. The comparison was done between both experimental groups and the control group. The analysis of variance did not yield

significant results to prove that the mean of the experimental groups and control group was different to the population mean at $p < 0.05$, $F(1.89002) = 2.53024$, $p = 0.153666$.

As comments from the learners tended to vary between struggling to remember to access the site, to the site being very convenient for accessing homework, there was no consensus on whether the learning management system aided their ability to keep organised. A comment by a learner in Group N stated that they struggled to find the relevant content to study as the content was grouped according to the part of the story in which it was presented.

Even though Group G, in particular, found the tests easier than the other groups, their average was relatively close to the grade average. The general attitude towards the class test was that they were neither easy nor hard. Even though Group G found the work harder to keep track of than the other groups, this average was relatively close to the grade average. The general attitude towards keeping track of classwork was neither easy nor hard. Most classes found that the site was slightly harder to study from than from physical class notes. All three groups admitted that they always had access to their notes.

This raises the consideration that the system might have been more effective in a school or environment where a technology policy was already in effect. If students already felt comfortable with incorporating the use of their device into their studies, the transition from physical notes to electronic notes may not have elicited such mixed reactions.

6.1.4.3 The use of gamification

Between the experimental groups, Group N had a strong positive attitude towards the use of leaderboards, while group B had a moderately strong attitude towards the use of leaderboards.

Between the experimental groups, both groups had a strong positive attitude towards the use of Experience points as an in-game indication of progression and having a user profile that represented their achievements and badges. A 2-tailed t-test comparing attitudes towards Astro-Points in item 3.4, between the narrative based Group N (4.5; 0.53) to non-narrative based Group G (4.13; 1.03) conditions; $t(35) = 1.06679$, $p = 0.296681$, showed no significance between groups. There was no

group for comparison in attitude towards the use of experience points, as the control group did not receive this treatment.

All three groups seemed to feel neutral towards the use of Edmodo, the online forum and the use of the tutorial. Group N seemed more positive than the other two groups towards the tutorial though. As Edmodo was an external social forum, it may raise the issue of whether it was a good fit for the system. As learners were redirected to Edmodo from the system, it may have been an unrelated external site. It might be more effective to have a forum that is embedded in the learning management system.

All three groups felt positive towards the use of a calendar, with the control group less positive than the other two groups. Group N was overwhelmingly positive towards the use of the newsfeed. This may suggest that the incorporation of a calendar and newsfeed is important to the design of a learning management system. As Group N was driven by the narrative, the inclusion of interesting facts of their story may have made their experience more enjoyable than having system updates alone.

Between the experimental groups, both groups seemed positive towards the special events, where Group N was slightly more positive than Group G. Group G felt strongly positive towards the use of extra assignments, while Group N seemed to feel neutral towards it. The control group liked the idea of extra assignments for rewards. Both groups had also felt positive towards the use of badges. Between the experimental groups, both groups were positive towards the use of upgrades, with Group G being more positive than Group N. This would indicate that obtaining intangible rewards, such as in-game currency and badges for completing both core and discretionary tasks, are an effective way of motivating learners. This could have further been elaborated by assessing learners who had completed the discretionary tasks.

6.1.4.4 Personal attitudes towards gamification learning management systems

Between the experimental groups, both test groups strongly enjoyed the game and did not find the work particularly difficult. Only Group G felt positive towards working in groups, while Group N and the control group were neutral towards group work.

All three groups felt neutral towards studying from a website rather than a workbook. They also did not feel that they spent more time studying Science during the intervention than they did before the program. All the groups were also neither positive nor negative towards rather working on a website than working from a textbook. Most participants had felt that the system had worked well on their electronic device. If the participants had leaners struggled to access the site, this may have affected the amount of time participants were able to complete their work.

From these findings, students expressed that they had enjoyed the entire experience and no aspect of the program left them feeling unhappy. Judging from the learner comments and in-class interaction, there was a positive atmosphere amongst the learners who seemed to be enjoying their classes. Both experimental groups enjoyed the use of gamified design elements, even though Group G had higher ratings of overall enjoyment. Irrespective of the actual effectiveness of the academic aspect of the system, learners enjoyed the use of the gamified system.

6.2 COMMENTS AND ATTITUDE SURVEYS

6.2.1 Week One Comments and Observations

The consensus amongst all three groups was that they were enjoying the system. Most students preferred not to comment on the attitude survey, however, most of the ratings were very positive. The control group made suggestions relating to work that was to be covered in the exams, but did not refer directly to the system. In relation to the overall rating of the system, week one's overall score was the most positive out of all three weeks surveys across all three groups.

There were a few issues with accessing the site and getting the schools iPad's and computers to load the site correctly. As it was the first time the devices were accessing the sites, it was necessary to save each site onto the device as a shortcut. This tended to waste a bit of learners' class time, however, it seemed to be a problem only evident in the first week.

The data capture sheets and learner profiles needed to be updated by the facilitator. This was quite time consuming at first, which may indicate that these sections could have been set up prior to the implementation of the system. As each learner had to be loaded into each program separately, this became very time consuming. A more automated system, or a system where learners can register themselves would have made this process easier and is a consideration for any further projects.

6.2.2 Week Two Comments and Observations

During the second week, students seemed to get used to the system. As the system was no longer fresh, there were a few more suggestions for improvements. Some students expressed their concern that they struggled to motivate themselves to learn the actual content and would prefer that the teacher still explain the work to them. A student from the control group commented that the design of the physical worksheets prior to the experiment were better than the digital ones. This may indicate a limitation with the website builder, as customisation options are limited. Some students expressed their anxiety over keeping up to date with deadlines. Throughout the year, all deadlines are recorded on the classroom's homework board. It may have been difficult for learners to remember to check their online calendar.

6.2.3 Week Three Comments and Observations

During the third week, there was a definite shift in the engagement of each group. The narrative-based group seemed to be losing interest and were not as keen as the non-narrative group to earn the in-game currency. The non-narrative group developed a few interactions where students were competing for positions on the leaderboard or were attacking each other with their perks. The control group seemed content, as the system was still different to typical classwork. One student in Group N even commented that they had not been keeping up with the story and did not realise there were specific introductory videos to each week. This indicates that the narrative-based system should have been less flexible, as learners may have been more immersed if the pacing allowed them to understand the game world. The non-narrative group seemed not to have the distraction of a storyline and focused more on the game mechanics to make their experience more meaningful.

6.2.4 Assignments

Some students suggested that there should have been fewer assignments, which may indicate that the spacing between the assignments may have been too close together. One student commented that they would have preferred physical worksheets. On the other hand, a few students seemed to prefer the online worksheets as opposed to receiving paper ones. Even though this seemed like a positive comment, completing physical projects is still an important skill. This may suggest that being able to incorporate physical projects into the digital system may make the projects more meaningful. This could be achieved in creating videos or photos that are to be used as objects within the system.

6.2.5 Group activities

Students expressed their anxiety and dislike for the group activities. Learners often complained that they struggled to get all their group members to contribute to the assignments. They explained that either students were not available to do the work or would simply not do the work, leaving the remainder of the assignment to the rest of the group.

The group activity was the only activity where students were happy not to hand in an assignment. Students who requested extensions, through the purchase of the relevant in-game perk, predominantly used them on group work assignments. A few students enquired whether the use of this perk would benefit the entire group, which raised concerns within the group on who should use their in-game currency. This raises a concern of how the game was structured to be fair. There may not have been a fair game dynamic here, as players could be coerced into using their earned points into purchasing something that would benefit others.

6.2.6 Experience and ability points

Students commented that they would have liked more opportunities to gain the in-game currency. Those that were more devoted found that they had to wait for more tasks to be set or released, which seemed to be frustrating for them. Learners frustration may not have actually have been a negative thing, as it shows they couldn't wait to participate.

There were a few verbal comments from learners, asking when their experience points or in game purchases would reflect on their profile. As most of the transactions and increases in experience had to be loaded by hand, it was difficult to give learners finite answers. It was very time consuming having to constantly check for changes in the in-game store and update the appropriate learner's profile. This limitation could have been avoided with the use of an alternative web design platform.

The control group suggested, as an improvement, that completing classwork be rewarded with some form of currency or points. There seemed to be a desire to turn the system into a game. A few students suggested the system be structured like a board game, where progress is constantly visible and tangible. Another student even suggested that the system be built into a serious-game, comparative to that of a modern sandbox game.

6.2.7 System issues

Students across all three groups seemed very positive towards using an online portal or system. Even though there was not as much buzz around the storyline in the narrative group, both experimental groups expressed they were enjoying the game dynamics. Students enjoyed the modern nature of the system, even though the system did make certain functions difficult. One student complained of the Google Form tendency to erase all work done if the student minimised the tab they were working on. This could be very problematic for students who want to do their classwork over the course of more than one session.

6.2.8 Mobile devices

In the final survey, one student commented that the use of phones may have been distracting. During class work, this was evident with a few students. Students who had finished all their work or felt that they have time to complete their work, often took part in distracting activities like playing a mobile game or browsing video streaming websites. Another student commented that they liked being able to bring their device to school.

Most learners seemed to use their mobile phones to access the site, as suggested in the post-test and analytics program. Very few learners accessed the site from a desktop computer. This may suggest that mobile phones may be an ideal medium to reach learners at home.

6.2.9 General issues

As the program was initiated at the end of the year, students had several stresses they were occupied with outside of the program. During the final week of the program, where the final academic test was positioned, there was a large governmental English test. A few students commented that they were struggling to study for both tests and would have preferred the science test be postponed.

The school examinations were also set to start in the week after the program ended. Even though the students were happy with the coverage of the science curriculum, many students commented they would have preferred to focus on other subjects during that last week. This may have led to a

decrease in engagement. Two students shared the sentiment that the project should have been run earlier on in the year or could have replaced the examination for the subject.

7 DISCUSSION

Based on the data analysis above, the narrative-based group seemed to show improved academic performance after receiving the narrative-based gamified system. Even though the group that received the gamified system only had higher academic averages, this was not statistically significant in comparison to their prior academic achievement in Natural Science. It was, however, unclear if the use of gamification improved academic performance in comparison to the control group.

Both experimental groups had positive attitudes towards the use of a gamification as well as the use of a learning management system. It was also anticipated that the use of a narrative to drive the gamified system, would be more engaging for learners. It was clear from the research that storytelling does yield positive academic results, while also being engaging. This was inconsistent with my findings, as the narrative-based system did not produce significantly better results. As stated previously, this may be due to many different factors. As the use of narrative was restricted by the limitations of the medium, a Google web site design, the effectiveness of how the narrative was implemented could have affected the results. This could be a concern for future research, where the narrative plays a larger focus and should be revised to improve engagement.

In relation to the use of gamification in learning, both experimental groups seemed to outperform the control group. This would indicate that the use of gamification does improve academic performance. The experimental groups also had more positive attitudes towards , after having completed the program, to that of the control group. In contrast to this finding, the control group still seemed to have a positive attitude towards . This could suggest that the novelty of working on technology, instead of traditional pen and paper, may have influenced their attitudes. It would, therefore, be useful to test at what stage the novelty of using an LMS wears off over time. There was no clear indication from the literature for how long a gamified system should run. The gamification guide, a yearlong gamified learning program, did state that the program was successful over the course of the year[90]. The study did state that it was still effective at the end of the program but was not as effective as its beginning. The study was unable to state at what point it started to lose its effectiveness.

The main issue that arose when developing and implementing the different learning management systems, was in how the information was monitored and regulated. Most of the information

processing, except for the use of mathematical functions to summarise the numerical data, was done via the human facilitator. This was a tedious process which was prone to error and did not provide instantaneous feedback. The facilitator was, therefore, torn between helping the learners with understanding the content and updating it to provide rapid feedback. It was noticed by the facilitator that there is still a need for a content expert, as learners still enjoyed discussions and live interaction with their teacher. In relation to this finding, there is a need to automate the various data capturing functions of a learning management system. This harnesses the advantages a computerised system can provide by reducing human errors and providing the facilitator with more time to assist the learners.

The control group complained about the timing of the system which was stated in the post-test by a few learners. This could potentially have affected all other groups, however, there was no evidence of this as it was not reported by participants in the experimental groups. As the learners' examinations were taking place soon after the program, all the learners were feeling anxious. Therefore, it was not a problem with the system, but rather of the timing of its implementation.

7.1 Design Adjustments

During the experiment, there were a few adjustments to the system that were implemented across all three groups. This was due to the feedback from students, to ensure that they all had equal access to the course content.

The calendar was updated to include all assignment deadlines as well as the dates of when assignments were released. Assignment deadlines were originally listed on the main page under the news feed. Some students had expressed their concern as they struggled to find this information. A google calendar was incorporated, which listed all the assignment deadlines which students could add to their personal device's calendars. This ensured that learners did not need to constantly check the newsfeed, to remember assignment deadlines.

Course notes were added in the final week, where all the content available on the website were made accessible and printable. Students had complained that due to the approach of the examinations, they would rather study from worksheets that they could write on, as they were more

comfortable using notes to which they were accustomed. The worksheets were modelled and laid out in a similar manner to the website. Assignments were not included in the course notes. Information was copied directly from the content sections in the LMS's.

8 CONCLUSION

8.1 STUDY IMPLICATIONS

It is evident from the above results that the use of gamification as an adjunct to methods of instruction, incorporating an LMS, is engaging for learners. Given an appropriate time frame for running a gamified LMS, learners seem to enjoy the content with which they are presented more than if they were given just the content via an LMS. It is also evident, that learners seem to enjoy the use of a LMS to structure and present the content curriculum. Game mechanics such as the use of the leaderboard, purchasable perks earned through completing extra work, temporal activities and the use of an individual profile improved learner enjoyment.

Learner attitudes across all the attitude surveys and post-test showed positive results. Learners felt that they were more in control of the pace of their learning and that the weekly comment system allowed them to voice their concerns or what they had enjoyed. Learners did not have a positive attitude towards the incorporation of group work, which may have needed to be worked into the program more effectively. This shows that the use of a LMS does improve learner enjoyment. Learners seemed to enjoy the use of narrative elements amongst Group N, suggesting that they were engaged in their learning and the role play.

Academic performance across the test groups showed a positive improvement but was not significant between the experimental and control groups. This may have been due to the novelty of the system being implemented, the facilitator's influence on the system, difficulty of the course content and the difficulty of the formal tests used. The system was able to capture extra information that would not always be available to teachers, such as time stamping exactly when assignments were submitted and allowing the system to automatically mark assignments. This would be beneficial to teachers, as it may give more insight into the pace at which the class is working. The use of automatically marked assignments in conjunction with a system that calculates and summarises the classes' performance, may reduce the teacher's workload and help teachers identify struggling learners. This suggests that using a learning management system may be beneficial in the long term, with gamified systems being used periodically to improve engagement.

In comparing the use of a narrative-driven gamified system to the gamified only system, there seemed to be no significant improvement in academic results or extra enjoyment from learners. Many comments from learners showed that they were more interested in taking part in the gamified system, rather than following a storyline. The academic results from the system seemed to reflect the student's previous baseline academic results. A few students stated that they did not follow the storyline. This could be because of the implementation of the narrative, suggesting that a more linear presentation of coursework may be more effective in incorporating a narrative.

8.2 LIMITATIONS

One limitation would have been the time available for implementing the system. Due to the timing of the experiment, concluding a week before the start of their examinations, an earlier implementation date could have lowered stress during the experiment. From the attitude surveys it was evident that learners would have liked a bit more time for assignments and they had struggled to manage their time studying for other subjects. A few learners even commented that they would have liked some examination revision on the site for other learning sections. This could have had an impact on the results, as learners thought it was becoming a portal replacing typical teaching, even though it was only a temporary game. This perception may have made learners think it was an ineffective learning management system for the subject when it was used only to assist with studying one content section.

As the system only assessed the learners during the program, this would not account for whether the learners retained the information. A further post-test could have been administered a few months later, to assess whether the learners retained the knowledge. Long term retention could be used as another indication of the success of the learning management system. Due to the timing of the system and grade of the sample, this was possible, as the learners moved to a different school for grade 8. Keeping track of the sample and ensuring all learners completed the academic post-test in a similar environment was not possible.

The tutorial had to be kept short and information-heavy to reduce the time spent on learning the system. This could have influenced the learners understanding of the system. To account for this the tutorial could have been incorporated into the actual game system, where learners learn how to use the system through guided activities in the first week[92]. A game tutorial could even be hidden in

the increasing difficulty or complexity of its tasks. This would ensure that all learners were accessing the tutorial and were being eased into the system. Students who did not read the tutorial, or struggled to read, would have been disadvantaged in learning how the system works. One learner did not understand the system during the first week and rated the system very poorly. During the following weeks, this student began to understand the system, and his or her attitude towards it improved.

A personal observation as the facilitator for the running of the system, was that in its current form, it required constant attention. This was due to the limitation of the interactivity between the spreadsheet program and the website creator. As most of the inputs for the program were obtained using forms and summarised using spreadsheets, there needed to be a user who would interpret and upload the output onto the website. This was a laborious and time-consuming task, as the system needed to provide timeous feedback. This required the facilitator to check all the spreadsheets every few hours to interpret the new information. An example of this would be if a learner were to buy an extension on an assignment upgrade. The facilitator would have to check that classes upgrades spreadsheet, manually subtract the in-game currency from that learner's total on a separate spreadsheet and then add the relevant text and image to that learner's profile page. This may have had an impact on the learner's experience, as it difficult to maintain consistent timing of feedback. An automated system should, therefore, be able to integrate these databases and upload the relevant output to the learner's profile. This would both shorten the feedback time to make it instantaneous and remove human error in the form of the facilitator having to check and manipulate the correct information.

As it was a requirement of the school's skills-based policy, group work needed to be incorporated into the learning management system. Even though it was a required skill to be incorporated, the system may have benefitted by removing group assessment activities. This does not mean that group work should be taken out entirely. Instead, group work would simply not count towards any in-game currency or story progression. It could be used as a tool for creating discussions or generating ideas, but learners were happier to rely on their own work. Another suggestion would be to incorporate activities that would specify what each group member contributed to a group activity. This would make it easier to assess learners based on their contribution, while still teaching the skill of developing roles within a team.

Seeing that the study was also completed within a small grade of learners, there may have been a bit of crosstalk between groups. As each class was receiving a different form of their content, it may have been possible for learners to talk about their individual experiences in class. Learners may have felt either positively or negatively towards the fact that they are receiving a different system to that of their peers in other classes.

8.3 Future work

In relation to the observations above, there are several different issues that could be addressed with a future study.

It was not evident whether the time frame of the gamified system was too long or too short to hold learner's attention. It was clear that over time the gamified system was losing its novelty and, therefore, factors like learner enjoyment and academic performance would begin to show fewer positive results. Future studies should focus on the ideal duration for a gamified system to be most effective.

Learners seemed to have a positive attitude towards the use of groups and creating group identity. However, they did not have a positive attitude towards the use of group assignments. This may suggest that learners do enjoy being part of a group but would have benefitted from creating group roles and participating in activities that were conducive to group work. As the system used traditional group work activities, the actual activity was unable to make use of the learning management system, other than presenting the learners with in-game currency as a reward for completion. It did not show the learners how to work in a group but expected them to work in a group anyway. It may be beneficial to develop a method of creating group work that teaches students about group dynamics and cooperation, while making use of the potential of a learning management system.

Due to the limitations of the website creator, there were a few factors that could have made the narrative-based story more engaging. As most objects were framed as boxes within each webpage, presentation could not be made to look like that of a program used in a spacecraft. This effect could

only be achieved if learners were to watch the videos embedded into the site. Videos also had to be clicked on, to be viewed. This meant that learners who did not want to watch the videos or who simply skipped over them by mistake, would have missed out on part of the narrative. As a result, the narrative only progressed for learners who actively participated in every element within a web page. Learners who did not feel like reading the story, would have missed out on this experience. This could have made it difficult to distinguish between whether learners were enjoying the narrative or were enjoying the gamified system.

An observation made during the analysis of the final academic results was whether the program was too difficult or too easy in comparison to merely using traditional teaching methods for the section on Space. It may be relevant to compare the results of a similar age group, learning the same content and using the same formal tests.

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10 APPENDIX

10.1 APPENDIX A

Table 15 Post-Test Survey Items

Item Grouping	Item
The Use of Narrative	1.1 The Storyline (the mission to Mars)
	1.2 The Groups themes (Space ships, jobs in space and space inventory)
	1.3 The space pictures, labels and colours.
The Organisation of Curricula Content	2.1 I found the assignments easy.
	2.2 The content was difficult to understand.
	2.3 The tests were easy.
	2.4 I found it difficult to keep track of my work.
	2.5 It was easier to study from the site than from my notes.
	2.6 I always had access to the online notes.
	2.7 The most interesting section
	2.8 The most interesting extension assignment
The Use of Gamification Mechanics	3.1 The Leaderboard
	3.2 The Experience Points
	3.3 Astronaut Profile
	3.4 The Astro Points
	3.5 The Upgrades
	3.6 The Story Videos
	3.7 The use of Edmodo
	3.8 The tutorial
	3.9 Using Missions rather than Worksheets
	3.10 The calendar for deadlines
	3.11 The Newsfeed
	3.12 The extra videos
	3.13 The special events
	3.14 The extra assignments

	3.15 The extra games
	3.16 The badges
General Program Attitude Survey	4.1 I enjoyed playing the "Astro Quest" game.
	4.2 It was easy to learn.
	4.3 I liked working in a group
	4.4 I didn't like the class Edmodo forum.
	4.5 I liked the mission numbers as it helped keep track of where I was in the section.
	4.6 I spent more time studying Science than before.
	4.7 Learning should be presented like a board or video game.
	4.8 I would prefer to study from a website rather than from a worksheet or from my workbook
	4.9 I would like assignment deadlines to be available online at all times
	4.10 I would like to be able to earn perks or upgrades on assignments and extra credit in class
	4.11 I would prefer that the teacher decides what I have to learn
	4.12 I would like to try again using a website to learn a section in Science.
	4.13 It worked well on my electronic device
	4.14 I mostly used my:
General Qualitative Comments	5.1 Which statement best suited you when learning about space.
	5.2 Please leave some detailed feedback, as this would be extremely helpful as to whether or not Mr Shelton should try gamify the classroom again!
	5.3 How could this game have been improved?

10.2 APPENDIX B

Table 16 Table showing the average Likert scale rating for questions from the pre-test and post-test regarding attitudes towards gamification.

Question	Group	Mean Likert Rating		
		Pre-Test	Post-Test	change
4,4 I liked the use of Edmodo	Group N	3.538462	2.6	-1.13846
	Group G	3.294118	2.3	-0.99412
	Control	3.6	2.8	-0.8
4,7 Learning should be presented like a board or video game,	Group N	3.384615	3.6	0.2
	Group G	3.2	3.1	-0.1
	Control	3.7	3.4	-0.3
4,8 I would prefer to study from a website rather than from a worksheet or from my workbook	Group N	2.923077	2.7	-0.2
	Group G	2.94	2.4	-0.5
	Control	3.8	3.2	-0.6
4,9 I would like assignment deadlines to be available online at all times	Group N	4	3.5	-0.5
	Group G	4.4	4.4	0
	Control	4.3	4.9	0.6
4,10 I would like to be able to earn perks or upgrades on assignments and extra credit in class	Group N	3.8	4.3	0.5
	Group G	4	4.5	0.5
	Control	3.5	4.3	0.8
4,11 I would prefer that the teacher decides what I have to learn	Group N	3.3	3.4	0.1
	Group G	3.2	3.2	0
	Control	3.7	2.9	-0.8
4,12 I would like to try again using a website to learn a section in Science,	Group N	5	4	-1
	Group G	4.8	3.4	-1.4
	Control	4.8	3.8	-1

10.3 APPENDIX C

The appendix shows the individual marks of students in their individual classwork and their overall formal assessment mark (Test Mark). The test mark was used to compare the academic performance between the experimental and control groups.

Table 17 Summary of Academic Data

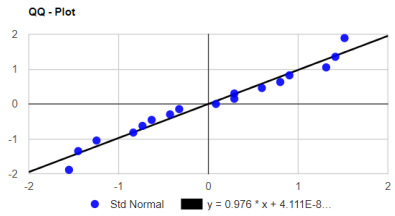
Summary of Academic Data						
	Group N		**Group G**		**Control**	
	Individual Classwork (informal Assessment)	**Test Mark (formal Assessment)**	**Individual Classwork (informal Assessment)**	**Test Mark (formal Assessment)**	**Individual Classwork (informal Assessment)**	**Test Mark (formal Assessment)**
Total	**40**	**50**	**40**	**50**	**40**	**50**
	64.30556	66	71.30952	71.80952	60.11905	61.19048
	65	35	77.5	92	72.5	65
	47.5	48	82.5	100	52.5	72
	52.5	68	82.5	64	47.5	46
	67.5	81	47.5	65	45	60
	67.5	84	85	64	85	96
	80	78	70	50	67.5	49
	90	51	67.5	54	55	64
	72.5	54	90	80	55	62
	70	86	32.5	23	87.5	88
	35	52	55	80	50	54
	60	60	80	94	57.5	80
	40	62	87.5	90	65	70
	65	46	62.5	46	80	88
	62.5	91	82.5	86	62.5	44
	75	59	42.5	69	45	67
	65	84	65	74	67.5	88
	65	64	87.5	84	57.5	28
	77.5	85	90	86	42.5	44
			75	82	55	46
			72.5	66	67.5	34
			62.5	59	45	40
mean		66		71.80952		61.19048
std dev		16.73672		18.75532		19.38716

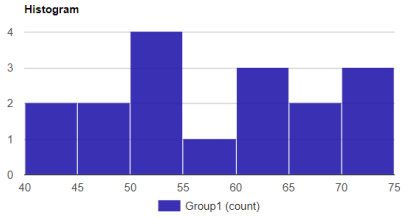
10.3.1 Shapiro-Wilks test for Normal distribution

Statskingdom online was used to assist the calculation for Normality using the Shapiro- Wilks test for Normal Distributions[93]. The statistics below were summarised according to the sites layout and diagrams were generated online.

10.3.1.1 Group N's academic results prior to experiment:

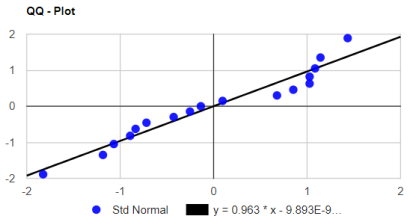
Since p-value > α, H_0 was accepted and it is assumed that the data is normally distributed. The p-value is 0.482221, hence, if we would reject H_0, the chance of rejecting a correct H_0, would be too high, at 0.4822 (48.22%). W is 0.951594. It is in the 95% critical value accepted range.

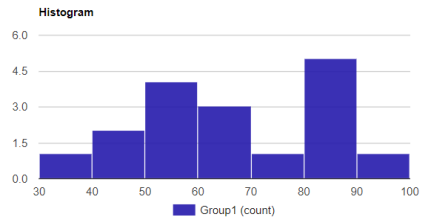




10.3.1.2 Group N's academic results after the program:

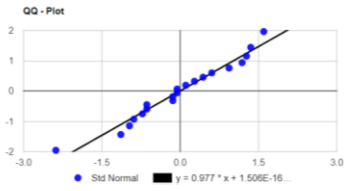
Since p-value > α, H_0 was accepted and it is assumed that the data is normally distributed. The p-value is 0.230683, hence, if we would reject H_0 the chance of rejecting a correct H_0, would be too high: 0.2307 (23.07%). W is 0.931513. It is in the 95% critical value accepted range.

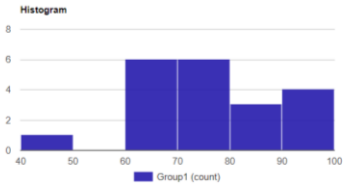




10.3.1.3 Group G's academic results prior to experiment:

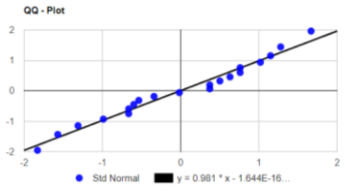
Since p-value > α, H^0 was accepted and It is assumed that the data is normally distributed. The p-value is 0.677830, hence, if we would reject H^0 the chance of rejecting a correct H_0, would be too high: 0.6778 (67.78%). W is 0.966402. It is in the 95% critical value accepted range.

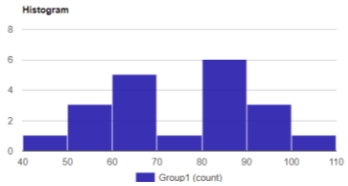




10.3.1.4 Group G's academic results after the program:

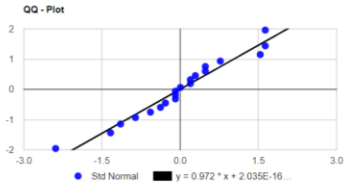
Since p-value > α, H_0 was accepted and it is assumed that the data is normally distributed. The p-value is 0.655676, hence, if we would reject H0 the chance of rejecting a correct H_0, would be too high: 0.6557 (65.57%). W is 0.965371. It is in the 95% critical value accepted range.

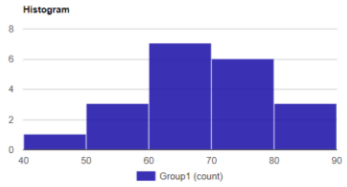




10.3.1.5 Group C's academic results prior to experiment:

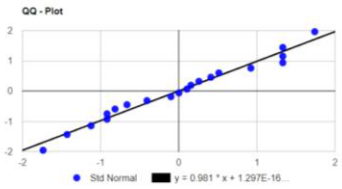
Since p-value > α, H_0 was accepted and It is assumed that the data is normally distributed. The p-value is 0.501037, hence, if we would reject H_0, the chance of rejecting a correct H_0 would be too high: 0.5010 (50.10%. W is 0.957808. It is in the 95% critical value accepted range.

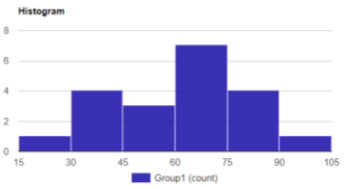




10.3.1.6 Group C's academic results after the program:

Since p-value > α, H_0 was accepted and it is assumed that the data is normally distributed. The p-value is 0.676323, hence, if we would reject H0, the chance of rejecting a correct H_0 would be too high: 0.6763 (67.63%). W is 0.966332. It is in the 95% critical value accepted range.





10.4 APPENDIX D

Web Analytics Data

Table 18 Table showing the average time spent on web pages relating to assignments.

Assignment Data						
Assignment Number		**Group N**	**Group G**	**Group C**	**Total**	**Average**
1	**Average time on page**	0:04:44	0:04:05	0:04:32	0:13:21	0:04:27
	Number of views	84	112	90	286.00	95.33333
2	**Average time on page**	0:02:55	0:02:43	0:02:23	0:08:01	0:02:40
	Number of views	104	90	79	273.00	91
3	**Average time on page**	0:05:11	0:03:55	0:04:56	0:14:02	0:04:41
	Number of views	75	158	95	328.00	109.3333
5	**Average time on page**	0:04:00	0:05:07	0:06:09	0:15:16	0:05:05
	Number of views	40	67	66	173.00	57.66667
6	**Average time on page**	0:02:48	0:02:29	0:03:42	0:08:59	0:03:00
	Number of views	68	124	108	300.00	100
Total average time on academic page		0:03:56	0:03:40	0:04:20	0:11:56	0:03:59
Total number of views of academic pages		74.20	110.2	87.6	272.00	90.66667

Table 19 Table showing site usage statistics during school hours 08:00 – 14:15

	Group N			**Group G**			**Group C**		
Session Duration	Users	Sessions	Page views	Users	Sessions	Page views	Users	Sessions	Page views
0-10 seconds	107	237	283	131	267	342	88	199	227
11-30 seconds	62	64	194	77	86	237	35	35	99
31-60 seconds	51	51	172	73	78	284	34	34	101
61-180 seconds	99	101	593	167	171	905	63	63	281
181-600 seconds	106	106	1003	205	207	1631	83	83	554
601-1800 seconds	158	159	2023	252	253	2884	145	146	1260
1801+ seconds	38	38	721	70	70	1304	20	20	280
Total	621	756	4989	975	1132	7587	468	580	2802

Table 20 Table showing site usage statistics after school hours 14:15 – 07:59

	Group N			Group G			Group C		
Session Duration	Users	Sessions	Page views	Users	Sessions	Page views	Users	Sessions	Page views
31-60 seconds	51	51	172	73	78	284	34	34	101
61-180 seconds	99	101	593	167	171	905	63	63	281
181-600 seconds	106	106	1003	205	207	1631	83	83	554
601-1800 seconds	158	159	2023	252	253	2884	145	146	1260
1801+ seconds	38	38	721	70	70	1304	20	20	280
Total	452	455	4512	767	779	7008	345	346	2476

10.5 APPENDIX E

The following are screen captures of the experimental group's websites. Each of the following corresponding pages relate to how the site looked during the third week of the programs implementation. The comparisons show the narrative based gamified system on the left, with the gamified only system on the right.

10.5.1 Home Page

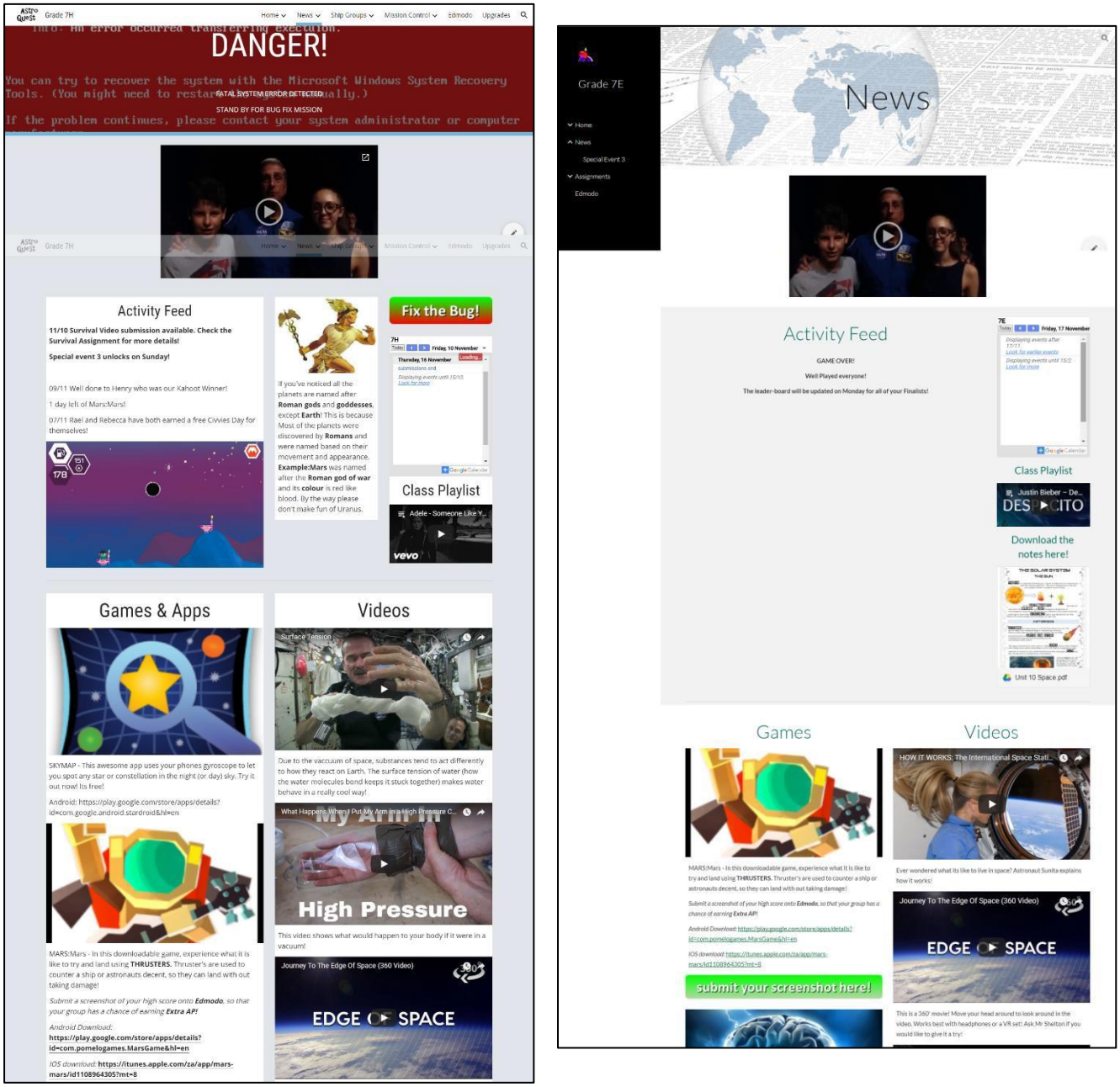
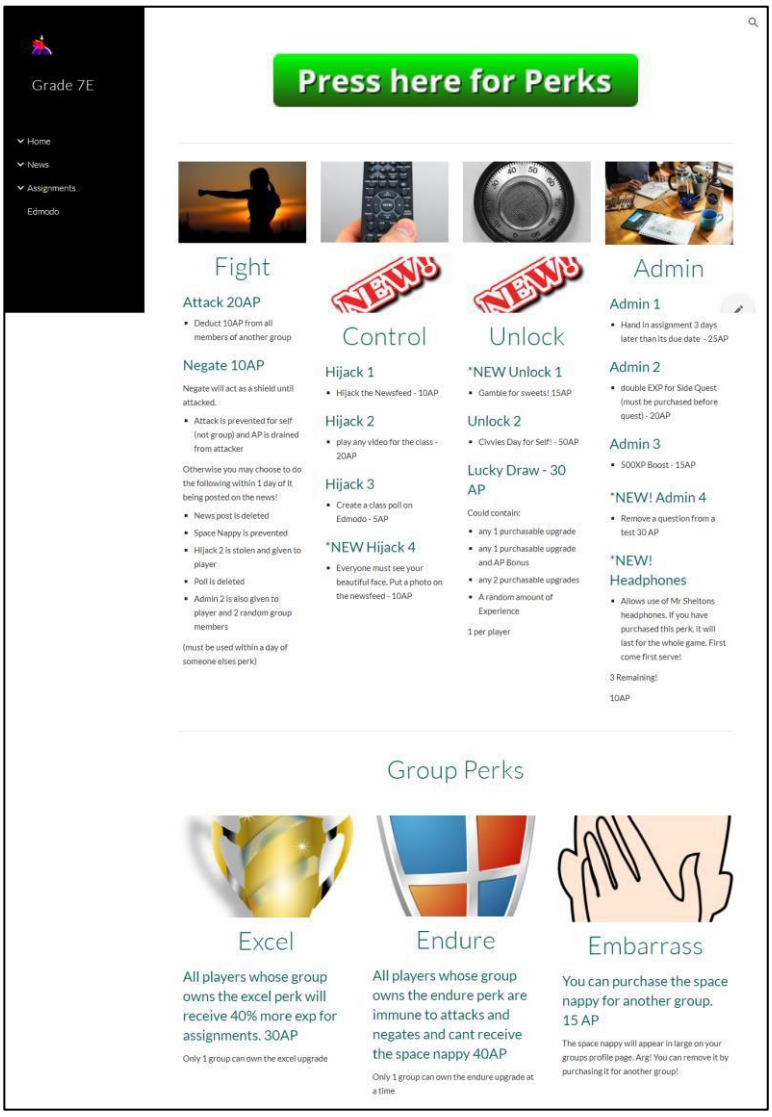
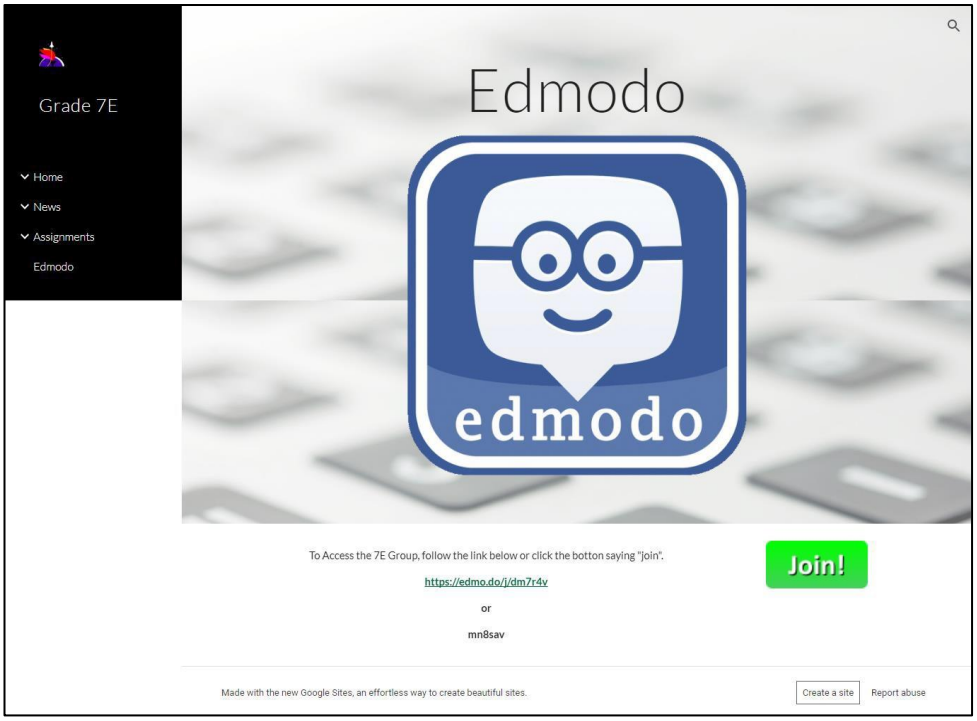


Figure 3 Group N - Home Page

10.5.2 In-Game Stores

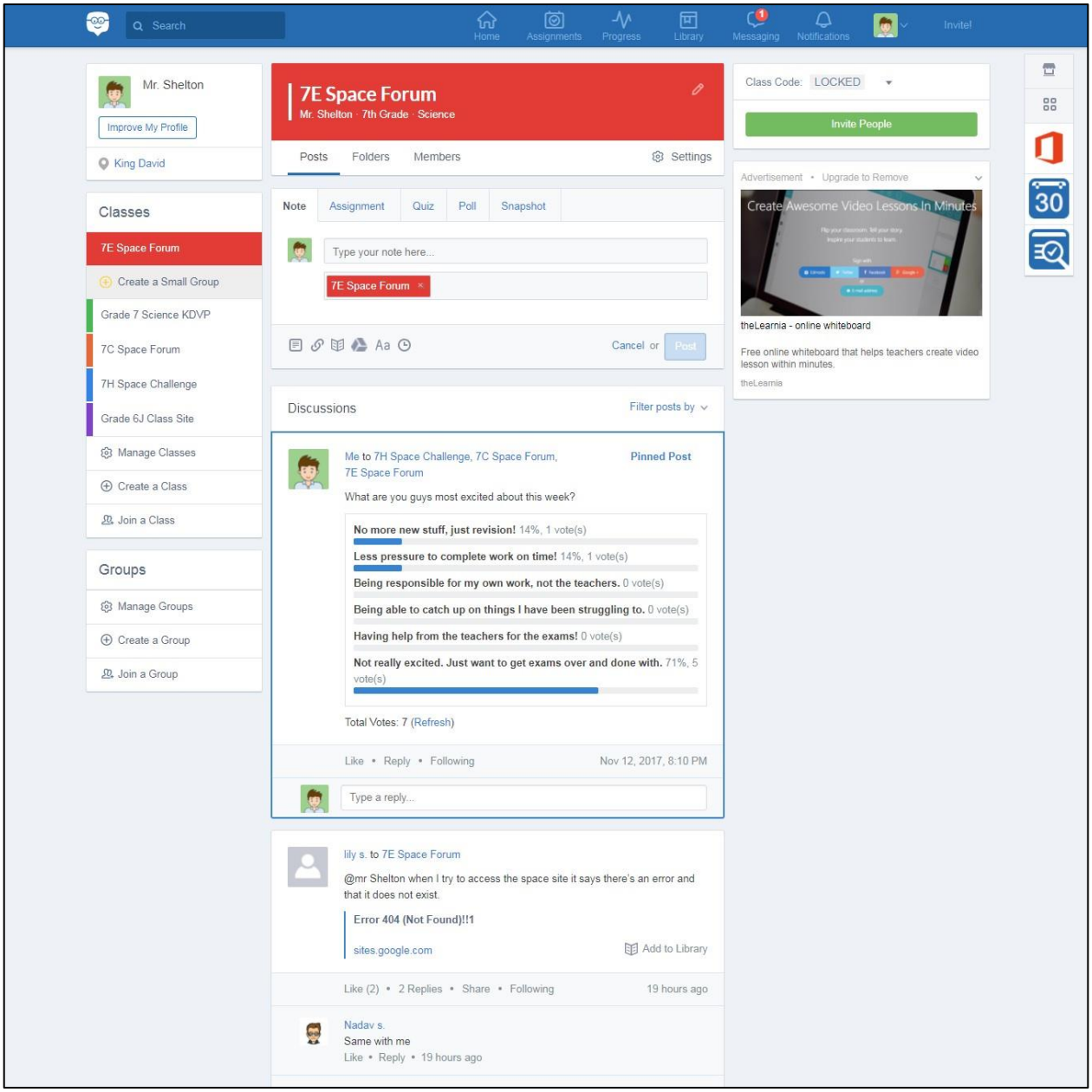


10.5.3 The social forums (Edmodo's) redirect page

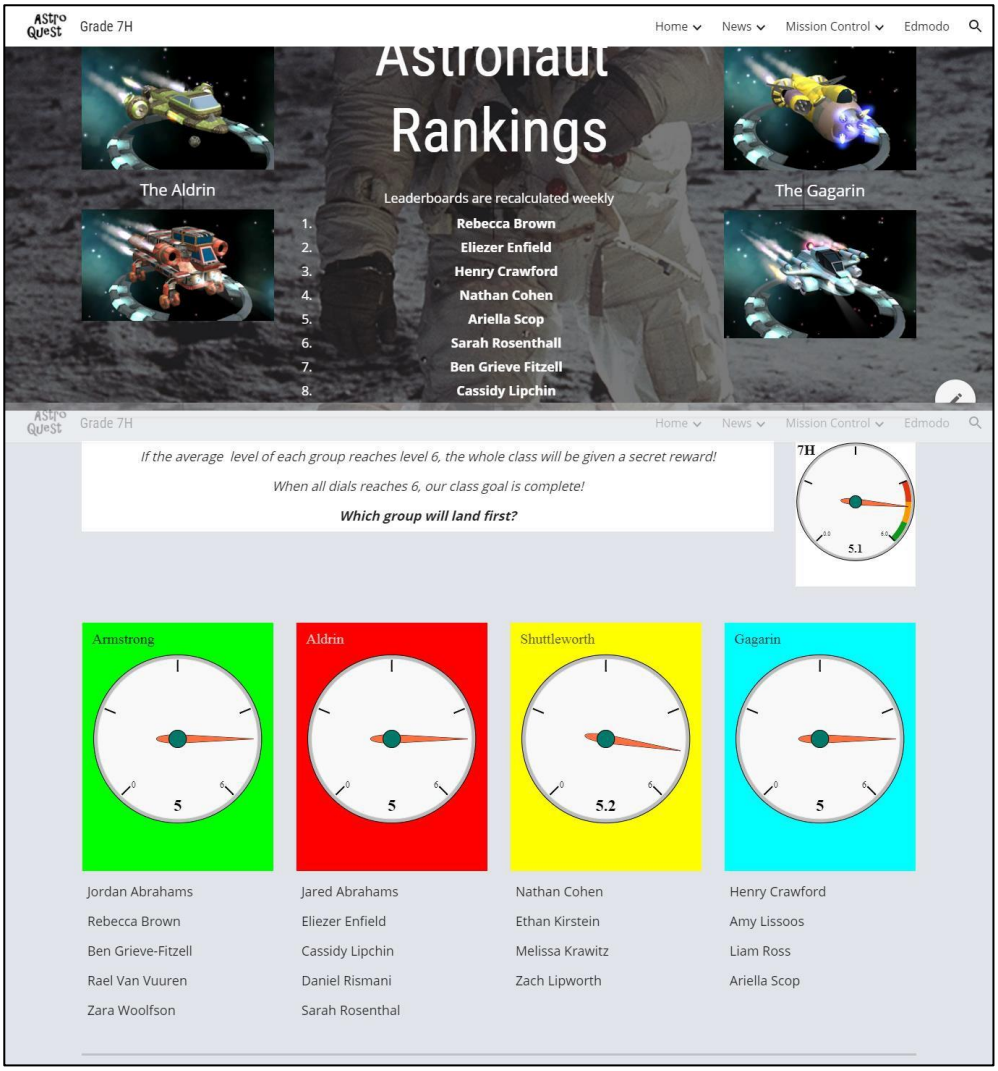


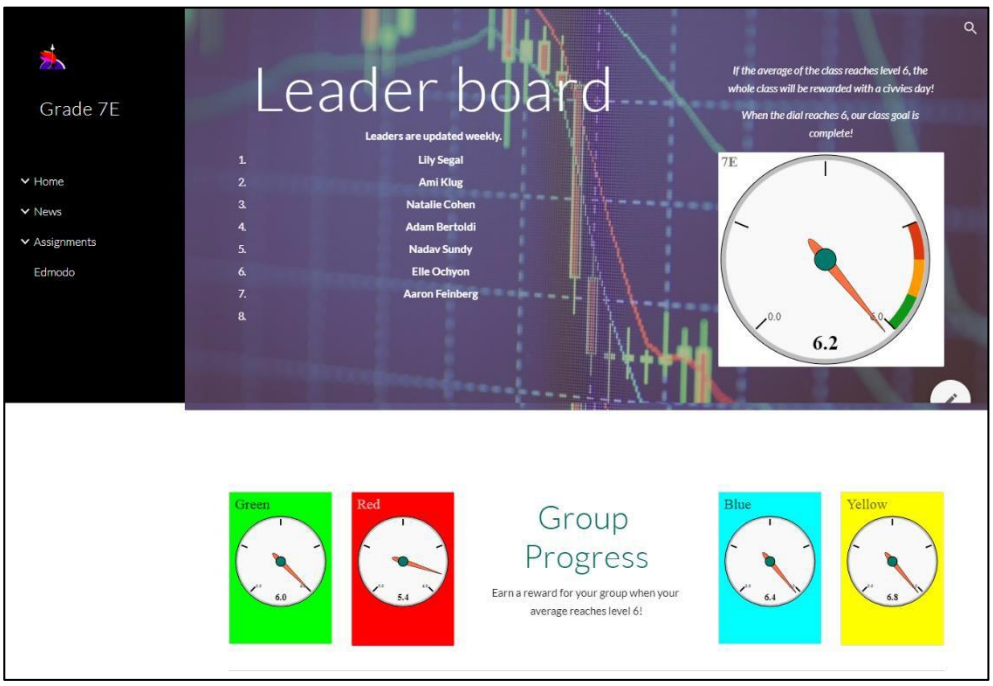
10.5.4 Edmodo forum feed

The Edmodo forum feed was kept constant between groups, as there was no alternative for creating a separate system for monitoring social communication.



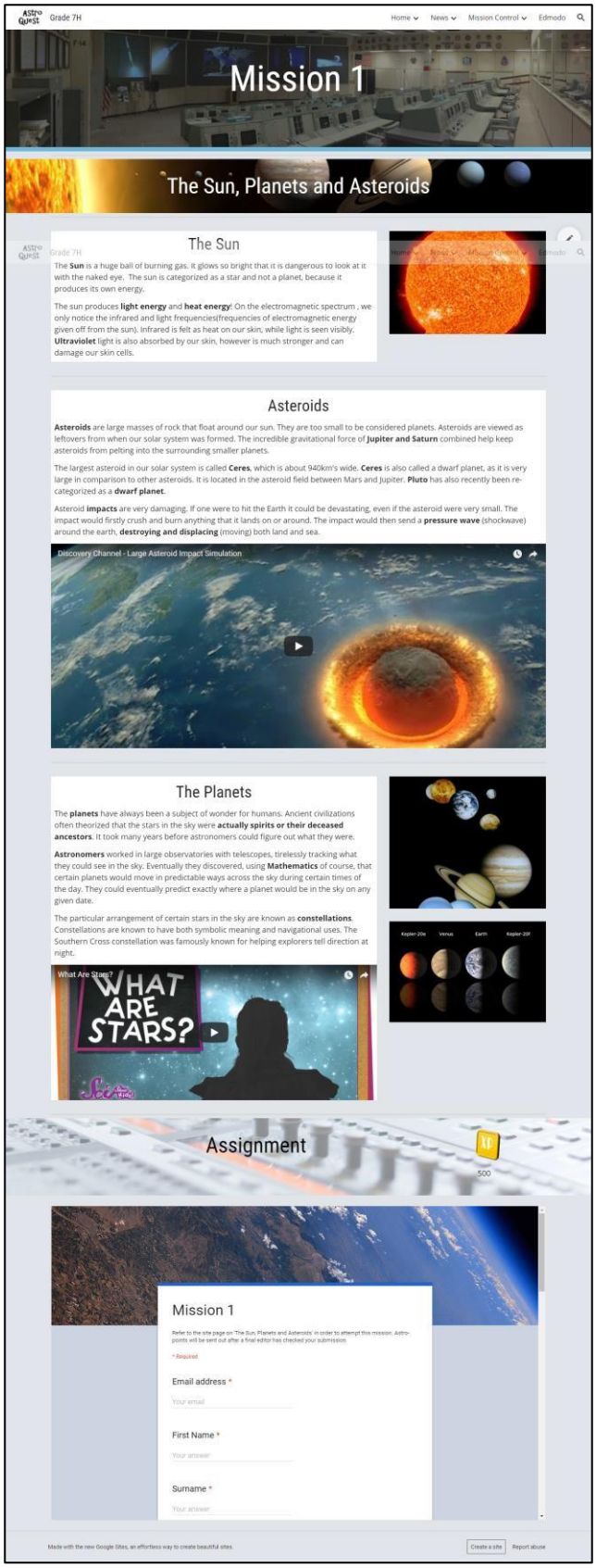
10.5.5 Leaderboard and Group Page

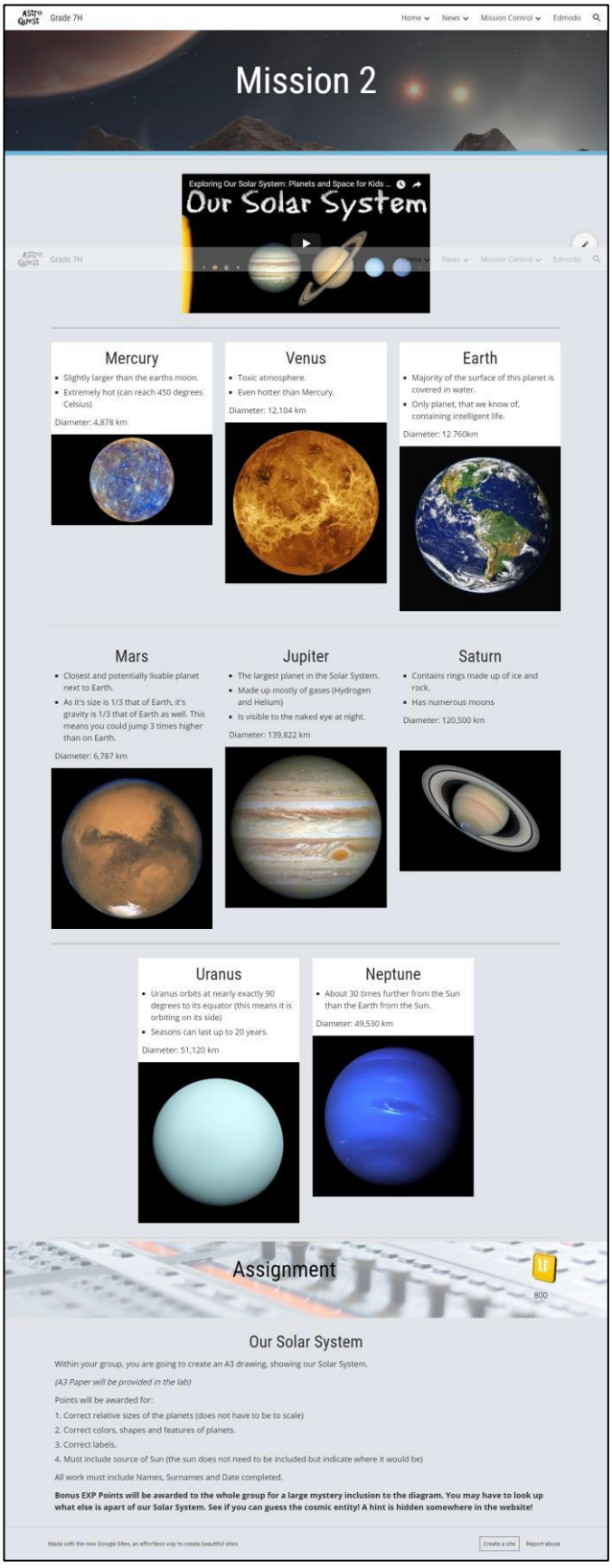


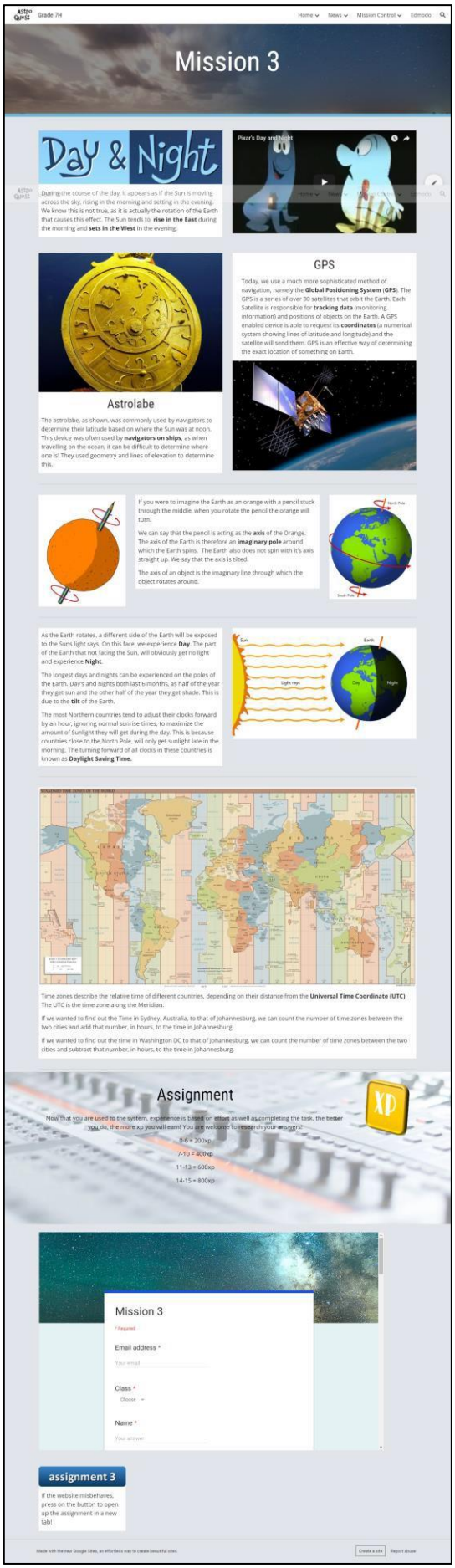


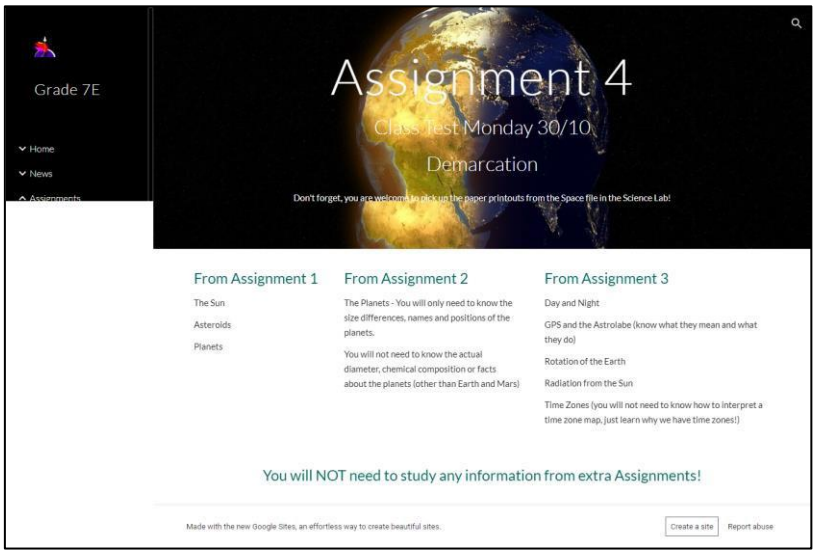
10.5.6 Assignment Pages

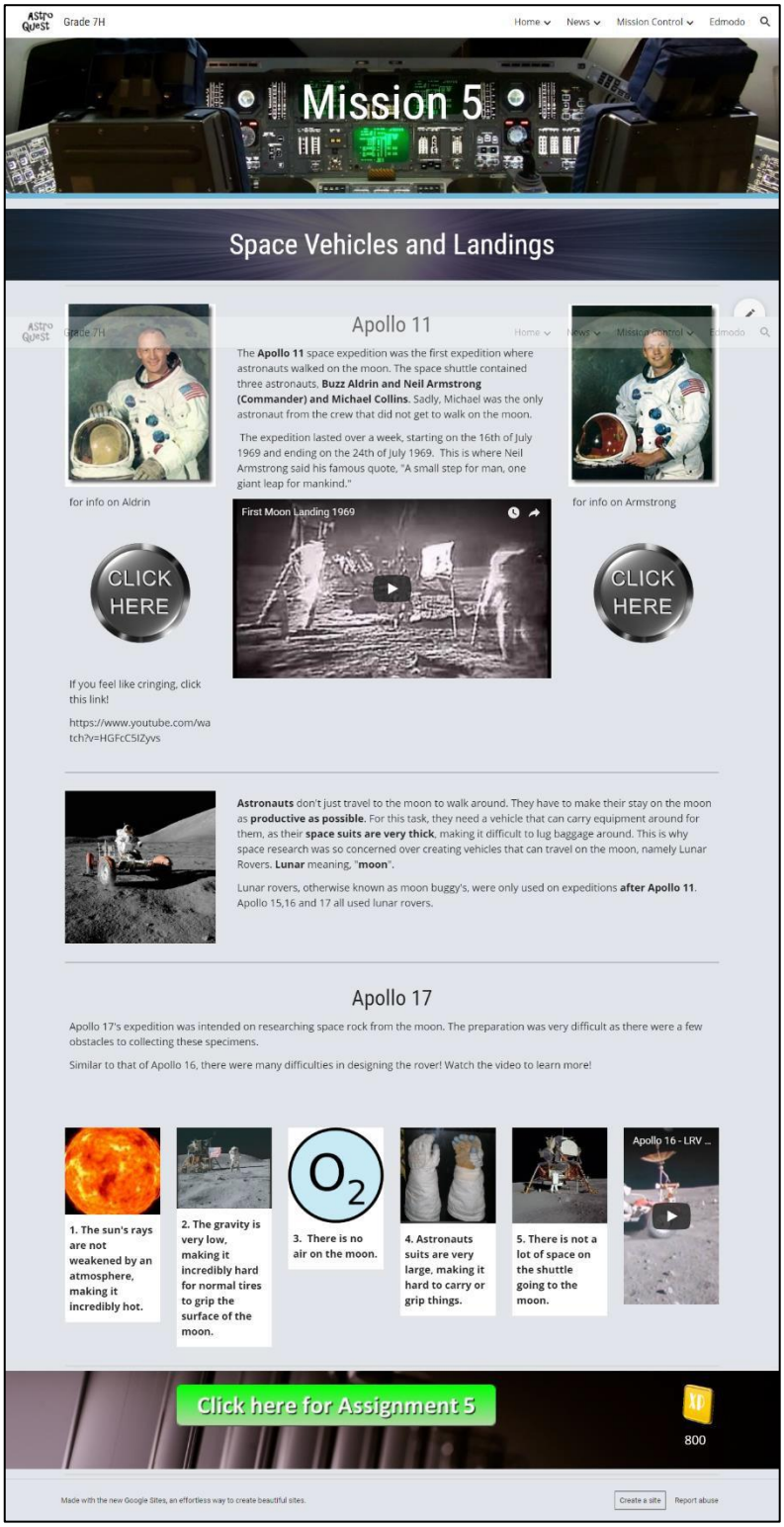
Assignment pages were identical across all three groups, as to ensure the groups received the same content.






Grade 7H
Home
News
Mission Control
Edmodo
Mission 3
Day & Night
Pixar's Day and Night
During the course of the day, it appears as if the Sun is moving across the sky, rising in the morning and setting in the evening. We know this is not true, as it is actually the rotation of the Earth that causes this effect. The Sun tends to rise in the East during the morning and sets in the West in the evening.
GPS
Today, we use a much more sophisticated method of navigation, namely the Global Positioning System (GPS). The GPS is a series of over 30 satellites that orbit the Earth. Each Satellite is responsible for tracking data (monitoring information) and positions of objects on the Earth. A GPS enabled device is able to request its coordinates (a numerical system showing lines of latitude and longitude) and the satellite will send them. GPS is an effective way of determining the exact location of something on Earth.
Astrolabe
The astrolabe, as shown, was commonly used by navigators to determine their latitude based on where the Sun was at noon. This device was often used by navigators on ships, as when travelling on the ocean, it can be difficult to determine where one is! They used geometry and lines of elevation to determine this.
If you were to imagine the Earth as an orange with a pencil stuck through the middle, when you rotate the pencil the orange will turn.
We can say that the pencil is acting as the axis of the Orange. The axis of the Earth is therefore an imaginary pole around which the Earth spins. The Earth also does not spin with it's axis straight up. We say that the axis is tilted.
The axis of an object is the imaginary line through which the object rotates around.
As the Earth rotates, a different side of the Earth will be exposed to the Suns light rays. On this face, we experience Day. The part of the Earth that not facing the Sun, will obviously get no light and experience Night.
The longest days and nights can be experienced on the poles of the Earth. Day's and nights both last 6 months, as half of the year they get sun and the other half of the year they get shade. This is due to the tilt of the Earth.
The most Northern countries tend to adjust their clocks forward by an hour, ignoring normal sunrise times, to maximize the amount of Sunlight they will get during the day. This is because countries close to the North Pole, will only get sunlight late in the morning. The turning forward of all clocks in these countries is known as Daylight Saving Time.
Sun
Earth
Light rays
Day
Night
Time zones describe the relative time of different countries, depending on their distance from the Universal Time Coordinate (UTC). The UTC is the time zone along the Meridian.
If we wanted to find out the Time in Sydney, Australia, to that of Johannesburg, we can count the number of time zones between the two cities and add that number, in hours, to the time in Johannesburg.
If we wanted to find out the time in Washington DC to that of Johannesburg, we can count the number of time zones between the two cities and subtract that number, in hours, to the time in Johannesburg.
Assignment
Now that you are used to the system, experience is based on effort as well as completing the task, the better you do, the more xp you will earn! You are welcome to research your answers!
0-6 = 200xp
7-10 = 400xp
11-13 = 600xp
14-15 = 800xp
XP
Mission 3
Email address *
Your email
Class *
Choose
Name *
Your answer
assignment 3
If the website misbehaves, press on the button to open up the assignment in a new tab!
Made with the new Google Sites, an effortless way to create beautiful sites.
Create a site
Report abuse


Grade 7E
Home
News
Assignments
Assignment 4
Class Test Monday 30/10
Demarcation
Don't forget, you are welcome to pick up the paper printouts from the Space file in the Science Lab!
From Assignment 1
The Sun
Asteroids
Planets
From Assignment 2
The Planets - You will only need to know the size differences, names and positions of the planets.
You will not need to know the actual diameter, chemical composition or facts about the planets (other than Earth and Mars)
From Assignment 3
Day and Night
GPS and the Astrolabe (know what they mean and what they do)
Rotation of the Earth
Radiation from the Sun
Time Zones (you will not need to know how to interpret a time zone map, just learn why we have time zones!)
You will NOT need to study any information from extra Assignments!
Made with the new Google Sites, an effortless way to create beautiful sites.
Create a site
Report abuse


Astro Quest
Grade 7H
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Mission 5
Space Vehicles and Landings
Apollo 11
The Apollo 11 space expedition was the first expedition where astronauts walked on the moon. The space shuttle contained three astronauts, Buzz Aldrin and Neil Armstrong (Commander) and Michael Collins. Sadly, Michael was the only astronaut from the crew that did not get to walk on the moon.
The expedition lasted over a week, starting on the 16th of July 1969 and ending on the 24th of July 1969. This is where Neil Armstrong said his famous quote, "A small step for man, one giant leap for mankind."
for info on Aldrin
for info on Armstrong
First Moon Landing 1969
CLICK HERE
CLICK HERE
If you feel like cringing, click this link!
https://www.youtube.com/watch?v=HGFcC5IZyvs
Astronauts don't just travel to the moon to walk around. They have to make their stay on the moon as productive as possible. For this task, they need a vehicle that can carry equipment around for them, as their space suits are very thick, making it difficult to lug baggage around. This is why space research was so concerned over creating vehicles that can travel on the moon, namely Lunar Rovers. Lunar meaning, "moon".
Lunar rovers, otherwise known as moon buggy's, were only used on expeditions after Apollo 11. Apollo 15,16 and 17 all used lunar rovers.
Apollo 17
Apollo 17's expedition was intended on researching space rock from the moon. The preparation was very difficult as there were a few obstacles to collecting these specimens.
Similar to that of Apollo 16, there were many difficulties in designing the rover! Watch the video to learn more!
1. The sun's rays are not weakened by an atmosphere, making it incredibly hot.
2. The gravity is very low, making it incredibly hard for normal tires to grip the surface of the moon.
3. There is no air on the moon.
4. Astronauts suits are very large, making it hard to carry or grip things.
5. There is not a lot of space on the shuttle going to the moon.
Apollo 16 - LRV ...
Click here for Assignment 5
800
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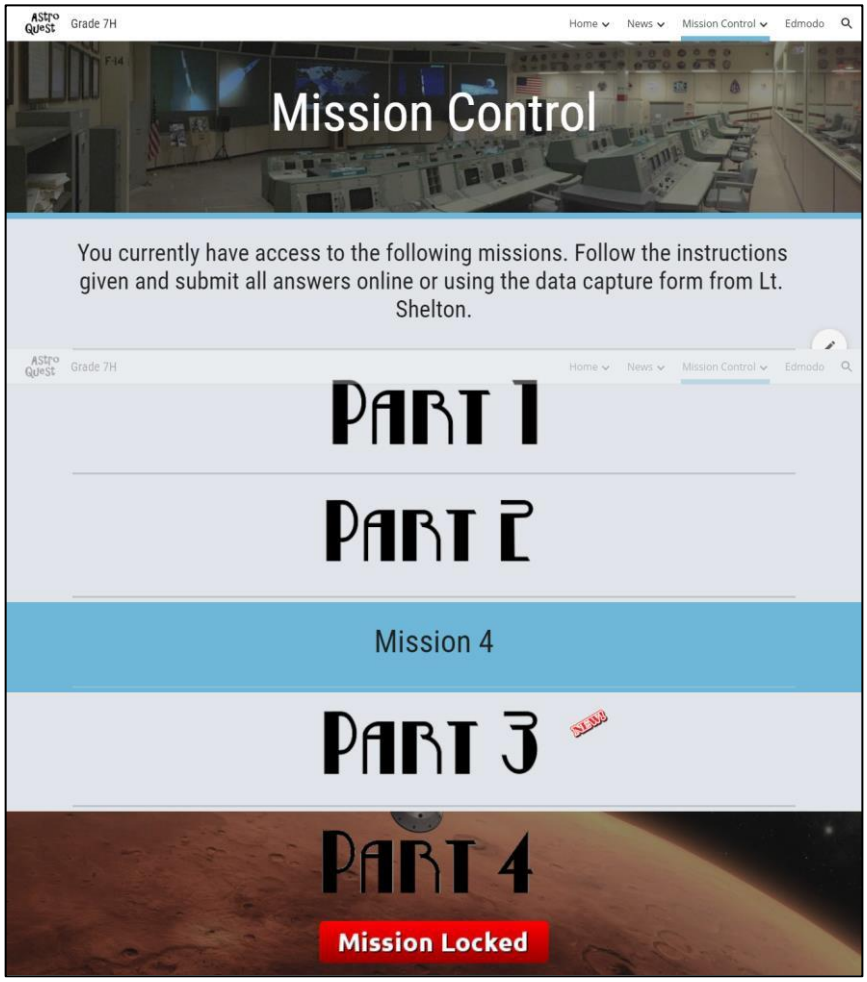
Telescopes and the SKA
What is a Telescope?
Telescopes are useful tools for making things that are far away look bigger. It uses a series of curved pieces of glass that refract (bend) light, to project an image to the back of the users eye. Essentially it works like a magnifying glass, except way more powerful.
Telescopes are extremely useful tools, however they can only detect light. Clever engineers over the years started to study radio waves. Radio waves are apart of the electromagnetic spectrum, a way that energy moves through space.
More powerful telescopes started to make use of this discovery, by not only detecting light (which sometimes doesn't reach the Earth from far away) but can detect radio waves (which can travel very far).
Not all satellites or telescopes look up into the sky. Satellites like the ones used for Google Earth are useful for mapping the land around us. They can give us detailed images of our cities and roads, providing us with important information.
The First Telescope...
Telescopes were first developed in Holland, as a means to help navigate on the Ocean.
Netherlands
Germany
... and its Inventor!
The first person to apply for a patent (a document that states they own the rights to produce the device) was named Hans Lippershey. The telescope had a X3 magnification.
NASA had originally built the largest and most powerful satellite used for space discovery and mapping. The Hubble telescope floats in space, orbiting the Earth while taking photo's of space. Click on the Nasa symbol above for access to authentic Hubble photographs!
The Square Kilometer Array is an organization whose goal is to develop the largest satellite array in the world. The array uses both South African and Australian deserts as sites for many powerful satellites. It shows the effectiveness of South African engineers and encourages investment from other countries.
SKA
SQUARE KILOMETRE ARRAY
SKA AFRICA
SQUARE KILOMETRE ARRAY
A square kilometer is essentially a million square meters in area. The advantage of having such a big satellite array is that it can scan the sky much faster and in greater detail than any other telescope in existence.
South Africa has shown its engineering prowess through its design of the MeerKAT array, an advanced telescope array that is now apart of the SKA's structure.
Assignment
XP
800
Constellations are also very interesting to look for. They are a distinct pattern of planets or stars, visible from Earth with the naked eye.
Each group member must produce an A4 page showing:
1. Their star signs constellation (what it looks like in the sky)
2. The name of their star sign
3. The mythology behind the star sign (the story from which the constellation comes from)
4. An image of their star signs symbol
Each group must staple their pages together like a booklet.
Bonus EXP will be given for the creative use of colour, (if the entire group has used colour!)
Pages will be marked individually, but must be handed in as a group! (so make sure your name is on the page that you did!)
Aries
March 21 - Apr 20
Taurus
Apr 21 - May 21
Gemini
May 22 - June 21
Cancer
June 22 - July 22
Leo
July 23 - Aug 22
Virgo
Aug 23 - Sept 22
Libra
Sept 23 - Oct 22
Scorpio
Oct 23 - Nov 21
Sagittarius
Nov 22 - Dec 21
Capricorn
Dec 22 - Jan 20
Aquarius
Jan 21 - Feb 19
Pisces
Feb 20 - March 20

10.5.7 Assignment landing page

Group N received an assignment landing page that was themed as a mission control hub. This tied into the story as learners were meant to be a part of a team intending to launch a space ship.



Group G received an assignments page that merely organised the assignments and did not group them according to an event happening in a story.