



Designing a feedback framework to reconnect students with learning in a game-based learning environment

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Feedback has great potential to benefit students' learning and skill development. Feedback designed in an effective manner can help improve a student's current performance by supporting their sense of curiosity and motivation and fostering a deeper engagement in the learning. Game-Based Learning (GBL) environments present an appropriate platform to implement feedback to facilitate progress monitoring and enhance curiosity and motivation. Through carefully designed feedback with the support of psychological theories in such environments, learners can become more immersed and interested in their learning. This allows for creating an environment where a learner feels more connected and empowered in their learning journey. This paper proposes a feedback framework with an understanding of the purpose and varieties of feedback mechanisms that can be presented to the learners at different levels within a digital learning environment through a statistics game to stimulate curiosity and motivation and help achieve the learning goals.

Keywords: Feedback, Statistics, Curiosity, Motivation, Game-Based Learning, Psychological Theories.

Introduction

In the current situation, many students lack the desired curiosity and motivation to learn in an academic context (Zichermann & Cunningham, 2011). In educational contexts, feedback is regarded as a significant element to influence curiosity and motivation positively (Rouleau, 2018). In recent times, the focus has shifted from face-to-face teaching to digital learning environments including game-based mechanics with a capacity to elicit curiosity and motivation (Alsawaier, 2018). Game-Based Learning (GBL) platforms can present good and meaningful experiences to deliver effective feedback (Erhel, 2012). For this study, feedback can be defined as information that is communicated to an individual in consequence of their performance to improve their learning by helping them understand their learning gaps and stimulating cognitive processes (Hattie & Timperley, 2007; Shute, 2008).

This paper proposes a design of a feedback framework based on the literature review that can help enhance curiosity and motivation in a GBL environment and empower students for improved learning outcomes.

The design of the feedback framework is based on the following hypothesis:

Hypothesis 1 (H1): Learners with a higher trait of curiosity and motivation engage better and perform well.

Hypothesis 2 (H2): Various types of feedback promote learners' levels of curiosity and motivation differently.

The next section reviews the relevant literature, followed by the design of the statistics game to implement the feedback framework to foster curiosity, motivation, and engagement in a GBL environment based on psychological theories. The conclusions are discussed in the last section.

Literature Review

Curiosity and motivation have been conceptualised as integral components of the learning process and support higher levels of engagement in learners to help them achieve their full potential in a learning environment (Garrosa, 2017; Stumm et al., 2011). Curiosity represents a desire to seek answers to unknown questions by encouraging exploratory behaviour in an individual (Berlyne, 1957). Motivation refers to an internal process that initiates and maintains the persistence of behaviour towards selected goals for an individual (Deci & Ryan,

2000).

Past literature asserts that the relevant psychological theories and models have provided educators with a heuristic approach to improving curiosity and motivation in traditional educational contexts (Arnone & Small, 1995; Deci & Ryan, 2000). The information gap theory formulated by Loewenstein (1994) suggests that the intensity of curiosity becomes higher when the information gap is smaller (Litman et al., 2005). The feeling of deprivation caused by missing information can be reduced by filling the knowledge gap with the presence of appropriate feedback (Arnone & Small, 1995). The Self-Determination Theory (SDT) of motivation states that when an individual's psychological needs for autonomy, competence, and relatedness are fulfilled, they become more self-determined. The Attention, Relevance, Confidence, and Satisfaction (ARCS) model of motivation claims that these four components contribute to the arousal and sustaining of curiosity in an educational environment (Keller, 1987).

Feedback can motivate and encourage a learner, help reduce anxiety, and make them feel cared for (Rowe & Wood, 2008). Feedback allows learners to achieve independence in learning and improves the level of self-regulation through monitoring (Chung & Yuen, 2011). Feedback has been shown to positively influence motivation and directly affect the learner's confidence and satisfaction aligning with ARCS design (Malik, 2014). It can help identify information gaps resulting in enhanced curiosity and intrinsic motivation (Hamzah et al., 2015). Quality feedback can help reduce the gap between high and low-achieving learners (Black & William, 2010). However, designing appropriate, effective, and balanced feedback has been a challenging task for educationalists (Boud, 2013).

The integration of technology in the learning process offers the potential to facilitate progress monitoring through numerous instructional strategies (Erhel, 2012). GBL is one of the interesting technologies in education that involves the addition of an actual game as part of the learning journey to teach new concepts, strategies, and skills to individuals (Alsawaier, 2018). A positive impact of game-based applications on motivation and achievement has been established in a past study (Erhel, 2012). Feedback design plays a significant role in a GBL platform to support players to track their own performance and encourage persistence in their learning efforts (Kiili, 2007).

There are three self-reflective questions that should be answered through feedback for effectiveness. The first question 'Where am I going' is about establishing a clear purpose and goals for learners. The second question 'How am I going' guides monitoring the learner's progress toward the goal so far. 'Where to next' question is about informing the learner about the next step to reach the goal by identifying the activities needed to make further progress (Hattie & Timperley, 2007).

Feedback can be provided at different levels namely: Task, Process, Self-Regulation, and Self level for achieving key learning outcomes (Black & William, 2010; Hattie & Timperley, 2007). Task level feedback is focused on the accuracy of the task and may include instructions to direct the learner towards correct information such as "You should include more information about the statistical formula". Process level feedback is specific to the activities to complete the task such as "This answer will make more sense if you could discuss all the strategies we talked about earlier.". Self-Regulation type of feedback can help enhance the learner's self-regulation strategies and direct their attention by investing more effort and commitment for further task engagement. One of the examples for such feedback can be "You already have a theoretical understanding of this concept. Check to see whether you have incorporated them in your previous step.". Self-feedback such as "That was an amazing response", and "well done", are considered to be least effective and less powerful (Hattie & Timperley, 2007).

Game Design with Feedback Framework

According to Shute (2008), there are different types of feedback that can be presented based on learning outcomes and learner characteristics. For the purposes of designing the feedback framework for the proposed research, four types of feedback have been considered. The first one is called Verification feedback also known as Knowledge of Result (KR) informs the learner about the correctness of their answer. The second one is called the Knowledge of Correct Response (KCR) type of feedback, where the correct answer is provided for the problem with no additional information. The third one referred to as Elaborated feedback consists of an explanation of the right or wrong answer provided by the learner. It might also guide the learner through appropriate hints or by reviewing instructions. The fourth one named Try-again feedback informs the learner about the incorrect response and allows more opportunities to attempt the question (Shute, 2008).

The feedback framework has been designed to help enhance the curiosity and motivation of a learner through effective and informative feedback strategies in a GBL environment. The foundation and the context of the game are derived from the United Nations Sustainable Development Goals (UNSDG) (Sustainable Development Goals, 2021) to teach basic statistics concepts such as mean, mode, and median as well as higher-level statistical concepts such as hypothesis testing, correlation, and linear regression. The game consists of three layers with each layer having different complexity of educational context to play with. In this multi-level game, a player can choose one of the three UNSDGs; No Poverty (SDG1), Health and Well-being (SDG3), and Quality Education (SDG4) to answer a set of statistics questions. Figure 1 shows the design of the feedback framework for the game.

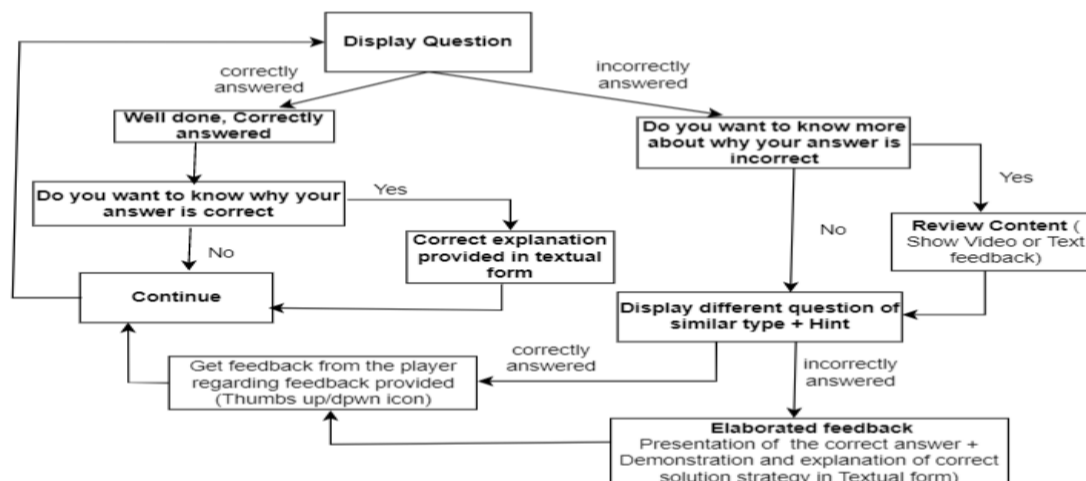


Figure 1: Design of the feedback framework

During the gameplay, the learner will be allowed multiple attempts to complete the question. If the question is answered correctly in the first attempt, there will be an option to review the correct answer demonstrating the use of verification feedback as suggested by Shute (2008). For incorrect answers, they can either review the content in a text or a video mode, or they can choose the option to attempt another question with a similar concept guided by a hint. This is an example of try-again feedback as suggested by Shute (2008). It also supports the sense of autonomy and fosters motivation by providing the choice of receiving feedback through video or text option (Deci, 2000). If they still answer it incorrectly, they can choose an option to get elaborated feedback comprising the knowledge of the correct answer and solution strategy in text form which will allow them to understand the required concept.

The use of feedback text such as 'well done' for correct answers indicates the use of self level feedback. Feedback at the task, process, and self-regulation levels have been incorporated through hints and elaborated feedback options in the game. The feedback text provided at all these levels aims to highlight the knowledge gap in the learner and help enhance curiosity and motivation in the learner by supporting the feeling of confidence, competence, and satisfaction. The feedback designed for this game answers three self-reflective questions as suggested by Hattie & Timperley (2007). The first question 'Where am I going' is covered by presenting specific learning goals to the learner at the beginning of each level in the game. The second question 'How am I going' is answered through a variety of feedback text while the final question 'Where to next' will be answered through self-regulated feedback instructions informing learners about their knowledge gaps and guiding them towards the next question to make further progress. The performance score is presented to the learner at the end of each level to keep them aware of their progress. The learner is also provided with an opportunity to provide their opinion about the feedback received.

Additional factors such as positivity and timeliness have also been integrated into the feedback to assess their impact on learning experiences and performance. Positive and timely feedback has been reported to improve performance through increased self-efficacy and desire to learn (Kim & Lee, 2019; Attali & Kliej, 2017).

Figure 2 presents snapshots of the statistics game designed for this research study. This scenario-based game has been designed to assist learners to understand the key concepts and learn formulas, approaches, and methods used in statistics. The game design portrays how statistics knowledge is used in real-life while also demonstrating the importance of UNSDGs.



Figure 2: Statistics game snapshots

Research Design

The proposed research is guided by the principles of Design-Based Research (DBR) methodologies including four phases that will allow the development of solutions by identifying the teaching and learning problems and achieving satisfactory outcomes after iterative cycles of testing and refinement (Reeves, 2007). Phase 1 of DBR is to analyse the problem; Phase 2 is to design and develop a potential solution; Phase 3 is to implement and evaluate; and Phase 4 is to reflect on the findings. For our experimental study, Phase 1 has focused on investigating how technology is currently being used to support learning in higher education; Phase 2 has focused on designing and developing a potential solution in a form of a statistics game. The initial game design is based on the literature review done in phase 1 and is informed by the existing design principles; Phase 3 requires us to better understand the effectiveness of the design principles and GBL environments. Multiple studies will be carried out during this iterative phase. The data from the studies will be collected and analysed to understand the effectiveness of feedback strategies. The iterative implementations and evaluations will lead to further design refinements; and in Phase 4 we will reflect on the list of the feedback strategies useful for motivating learners, and how this study intends to explore whether a variety of feedback can influence curiosity and motivational behaviour of learners and if that impact is reflected in the academic performance.

The process of building and evaluating the proposed framework will begin with a small-scale pilot study to investigate the game's feasibility followed by two large-scale subsequent studies. The ethics application to conduct this study is underway. This study will also examine if individual differences such as demographics, gender, personality, or learning style have any relationship to how learners' curiosity and motivational behaviour are stimulated, and performance is demonstrated in a GBL environment.

Conclusion and future work

Boredom, amotivation, disengagement, and disconnection are always a possibility in the learning journey that can be detrimental to the learning process. Well-designed feedback can be an effective facilitator of learning and can help enhance curiosity and motivation by providing required feedback at the correct time in a GBL environment. In this paper, we have proposed and discussed a feedback framework based on psychological theories that present a variety of feedback at different levels as suggested by the literature. This feedback framework has been designed in a GBL environment where statistics is taught to learners through UNSDG examples. To address the issues of disengagement of learners within online environments and help them reconnect with the learning process, this paper draws together a number of psychological theories and

motivational models to offer the design of diverse forms of feedback strategies in form of a framework that can improve learners' curiosity, motivation, engagement, and performance in a GBL environment. This framework will be evaluated with university students at the undergraduate level. It is anticipated that results emerging from the proposed study can guide future research and can be of great value to educators.

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