Introducing Failure as a Deliberate Instructional Strategy to Enhance Learning and Academic Outcomes

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***Abstract* - Students often dread to fail in an academic course and are worried about the consequence that follows. Failure seems to have a negative connotation among students at large. While the literature on organizational learning, innovation, and entrepreneurship often focus on failure as a critical ingredient to learning. What makes academic failure less acceptable to that of corporate? In this paper, we explore the importance of failure in the learning process and how the frequency of failure impacts learning and academic outcome. We conducted an experiment with sixty management students who played a business simulation game. We measured their academic response to failure, their perception about their performance, and the perceived importance & relevance of the task. We found that in a situated learning environment, students tend to persist in the event of encountering failure and not relent.**

Keywords—Failure, Learning, Group Behavior, Situated Learning Pedagogy, Serious Games, Game Based Learning.

I. Fail Fast, Fail Often

Failure is an integral part of exploratory learning. The literature on organizational innovation and entrepreneurship emphasized on the importance of experimentation, and the presence of conducive organizational structures and incentive programs to foster innovation [1]. Experiments are not always successful, and by nature iterative, therefore, failure is key to any successful experiment. Popular wisdom suggests that failure is the stepping stone for success and also provides valuable insights for future efforts.

Fail often and Fail fast is an adage popularized by the entrepreneurship fraternity, and they even happen to celebrate failure. Large organizations, on the other hand, incentivize and encourage the employee to experiment and have constituted separate reward programs. If failure is such an essential component of learning, why does it seem to have a negative connotation and impact on academic learning?

The failure rate in academia is alarming. In the US, an estimated 30 million students have enrolled and dropped out of school over the past twenty years [2]. The report published by the National Center for Education Statistics, 2017 estimates that over 44 million Americans owe 1.4 trillion in student debt and of which 40% of students will never graduate and therefore lose the ability to repay the loan. Failing to complete a degree would mean that the student would have failed in various tests, tasks, and assignments given to them [3].

Some students who experience such failure relent, leading to academic failure. The way the curriculum is structured in most schools often warrants students to have long term goals, which require multiple goal-directed behaviors [4], and they commonly involve failure.

For example, while completing a course in Economics, students might miss deadlines or fail to meet the minimum grade required to pass the course. Such failures are referred to as "sub goal" failure and can lead to behaviors jeopardizing long term goals, where the student relent and fails to put required efforts or on the other hand, persist by increased efforts towards the long-term goal [5].

Sub goal failure triggers a host of emotions and cognitive responses, which, in turn, evokes subsequent goal behavior [6]. For example, missing a deadline could evoke a cognitive response whereby the long-term goal is replaced by a short-term goal resulting in relenting or avoiding. Alternatively, not preparing for an exam, can trigger guilt, which in turn increases persistence [7]. Students experience constant behavioral dilemmas when they encounter such sub goal failure. They involve in either persistence promoting or relenting promoting responses concurrently [8].

Researchers in the past have also posited that failure is not only a key determinant factor in predicting academic performance [9]; it also plays an integral role in the learning process. The literature on game-based learning and simulation has often spoken about providing a risk-free environment for participants to experiment and learn through failure. Increasing the learning outcome by managing failure in a controlled environment would lead to promoting persistence behavior among students and thereby improving academic performance.

Despite the growing body of literature on learning and pedagogy, little research has been done on failure, and its impact on learning, the conditions that are conducive for failure, and how does social learning environment help an individual cope up with failure and perform better. In this paper, we intend to understand the student's response to failure while playing a business simulation game STRATUP (figure 2) and how group behavior and an individual's disposition to failure impact performance.

II. Learning from Failure

Cognitive psychologists believe that learning happens through the process of acquiring, storing, and manipulating information [10]. Knowledge is stored in packets called schema, which facilitates easy retrieval and processing. The literature on social cognition investigates how the social context influences the information that is acquired and processed.

Traditional pedagogies used in academic institutes are described as "technical" learning pedagogy [11]. The primary objective of this approach is to transmit facts, theories, and its application at an abstract level. They emphasize primarily on learning concepts and models and not skills. The learning is an individual act rather than a social interaction activity. In this approach, the objective of exams is to test the ability of a student's recall. They measure what is learned and draw conclusions about their knowledge. This model of learning fundamentally relies on the principle that knowledge occurs through acquisition and transmission of information [12].

Learning happens when an existing schema is appended or challenged [13]. Researchers have found that changing existing schema is challenging; however, the ability to create a new schema and append existing is valuable. Figure 1 presents the connection between the pedagogical approaches and their impact on schema creation. Traditional pedagogies rarely allow students to understand and challenge their schema. The instructor is always constrained by time, and the collective nature of the classroom does not provide enough room for challenging existing schema, leave alone create a new one.

Not only does traditional pedagogies offer minimal impact on modifying or creating a new schema, but it also offers minimal scope for failure. In such a setting, the student experiences failure only when they are assessed and not during the process of learning. Failure is not an inbuilt component of this pedagogical approach to facilitating learning; instead, failure becomes an outcome of an assessment. There is a perceptible time difference between one event of failure to the other, and hence a student who attaches higher importance to the outcome and finds the course relevant is bound to experience disappointment and hence would either have to respond by relenting or persisting.

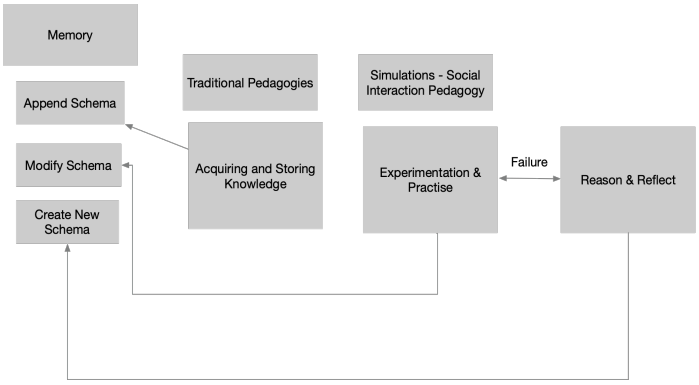

Fig. 1. Pedagogy and impact on an individuals schema

The time lag between one event of failure to the other brings about the prominence of the event. Therefore, the focus is on the outcome and not on the process, which in this case is learning. In contrast, in a social interaction pedagogy that integrates social cognition theory and technology such as computer-based simulations, a student is engaged in the process of finding solutions through interaction with peers and characters in the game. Through continuous experimentation and exploration, they would learn to modify the existing schema, and when encountered with failure, they tend to reason and reflect on the outcome, thereby creating new schema [14].

Computer-based simulations thus provide a psychologically safe environment that is conducive for learning, in which students learn through constant experimentation. Failure is rapid, and students experience failure at frequent intervals, which might not be perceptible. Failure, combined with the possibility to try multiple times, gives comfort to the learner, and this would drive persisting behavior than a relenting behavior.

In a social interaction pedagogy, the group plays a significant role in the learning process, during the process of interaction, individuals learn from and with their group members and impart what they know to their group members [14]. We posit that the individual coping strategies of failure are influenced by that of the team. Team members have a positive impact on the individual as long as the team collectively can cope up with failure. If the resultant response to failure is positive in a team, then there is a higher chance that individuals who feel dejected after failure will be influenced by the team to perform better.

We intended to test the following hypothesis.

Hypothesis 1: The frequency of failure in a risk-free environment has no impact on learning

Hypothesis 2: The teams that have a higher response to failure score will perform similar to the one having a low score.

In order to test the following hypothesis, we conducted an experiment using a business simulation game developed by one of the authors.

III. Experimental Environment

To simulate a social interaction setup, we used a multiplayer role-playing game-based business simulation. The game simulated a virtual business environment, where students were asked to don the hats of the head of marketing, finance, HR, operations, IT, and International Business. In the game, players run a virtual business, by performing activities similar to that of real life. Players are required to draw up a strategic blueprint, seek budget approvals, take strategic and tactical decisions, and

Fig. 2. Multi Player Game STRATUP

understand the impact of their decisions to take corrective actions.

A team comprises of 6 individuals', who will play the game on their computer terminal. Each participant will be accountable for their decisions, and the decisions are all interconnected. Players will have to seek and communicate information to other players to be able to execute their tasks well. For example, if the heads of the operation need to produce products, he/she would have to reach out to the player playing marketing role to understand the sales forecast and target, reach out to HR to communicate human resources requirements and to the finance head for budget approval.

Thus, in order to effectively run the virtual organization, each team member needs to participate actively and contribute. Even if one of the roles fails to perform, it will impact the overall team's performance, and hence, if a team is interested in performing, they would need to take all the members along.

Performance in the team is measured by a weighted average score computed on the team's revenue, profit after tax, the book value of share and employee develop index growth from the base year. The game also captures an individual's decisions and compares them with an optimal benchmark to understand an individual's performance. Since the game simulates a professional practice, it captures this evidence similar to that of a performance management system in a corporate setup and creates an epistemic profile comprising of parameters such as the player's decision making, planning, financial intelligence, goal orientation, and proactive behavior. The evidence is mapped against these parameters, and a network profile is drawn. The degree centrality of the network is computed.

IV. Experimental Setup

The game was administered to second-year management students. Sixty students participated in the experiment, out of which 32 were males and 28 females. Students were randomly assigned to teams and were asked to choose roles. Game rules and instructions were provided to the students, and they were given one hour of demo round to practice and familiarize themselves with the game environment.

The game had two distinct modules, planning and budgeting, where the team decides on the plan and seek budgets, and the second is the execution of the plan. The teams were permitted to sit together and plan for 50 mins at the start of every round. Subsequently, they were asked to sit separately and only communicate through chat with their team members while executing their plan. This setup ensures that individuals will be in a position to experience failure and try out options, and also we will be in a position to understand the impact of the team's response to an individual's failure.

V. Data Collection

Apart from capturing player's decisions at regular intervals and computing the team's performance, we asked the team to fill in a questionnaire at the end of the first, third, and fifth year of gameplay. The game was played over two days, where the teams completed five gaming years. All the members of the team were asked to record their response to the Academic Response to Failure Scale; researchers recommended that a new domain-specific scales will have to be developed by adopting the scenarios present in the original scale. The seven-point scale measured responses of an individual's relenting vs. persisting behavior.

We also gathered responses on the player's outlook to failure if he/she felt that they had failed in the task, team performance, individual performance, goal clarity, importance, and relevance of the task.

VI. Analysis

We wanted to understand the correlation between the variables of interest. Table 1 provides the correlation coefficients of variables. It was found that in the first year of the game, the higher the failure perception, the higher the persistence score, $r = 0.312$. This is quite understandable, in the first year of gameplay, players might not want to give up, though they feel that they are not performing well, they would like to continue playing and not give up early. This also correlated with the fact that higher the perceived importance and task relevance and goal clarity, the higher the individual performance ($r=.47$ & $.58$ respectively) also, across all three years, the higher the individual performance perception score, higher the team performance perception score. When an individual is performing well, he also feels that his team is also performing well in the game.

The individual performance perception score is correlated to the response to failure score. Across all three gaming years, the higher the response to failure, the higher the individual performance perception score. Therefore, when individuals are faced with failure in the game, they tend to persist more than relent, and hence, we conclude that in a situated learning environment, individuals tend to persist more than relent and are willing to cope with failure.

Table 2 provides information about the team's performance across the three gaming years and also the individual team member score computed and aggregated at the team level. The data clearly shows that the teams have consistently performed better than their previous tally, and also the cumulative score of the team computed by the game base on the degree centrality measure of the network shows improvement across the years. Therefore, even though the team's face regular failure, they tend to perceive it as a minor setback and not really look at it as a failure and hence persist than relent.

The frequency of failure matters, since in a business simulation game, individuals are constantly challenged by their team members and other competing players'. They happen to face frequent failures in terms of not being able to meet their goals. However, since the environment provides multiple chances of trial, players are not too worried about failure.

VII. discussion

Failure is an integral part of academic performance and learning. The extant literature has mainly focused on the importance of failure in organizational learning, while the literature on simulation and game-based learning acknowledges the importance of failure in the learning process, but very little is known about how it operates in a social interaction context and the importance of frequency.

In this paper, we have posited that the frequency of failure plays a critical factor in determining learning and academic outcome. If the task is relevant, valuable, and clear, individuals would perform better and possess the ability to respond to failure by persisting and not relenting and giving up

VIII. LIMITATION AND FUTURE RESEARCH

In the future, we intend to analyze the influence of an individual's response to failure and that of the team. We would like to understand the influence of the team's influence on an individual's response to failure. We also would like to introduce constant failure opportunities in traditional pedagogical approaches to understand their effects on learning and academic outcomes. The current study is limited in its experimental approach. We do not have a control group to compare results, which we intend to address in our next experiment.

Table I. CORRELATION COEFFICIENTS

Year 1

	Individual Perfoemance Score computed by game	*Team Rank*	*Failure Perception*	*Team Performance Perception*	*Task Relevance*	*Task & Goal Clarity*	*Individual Performance Prception*	*Relenting*	*Persistance*	*Academic Response to Failure*
Individual Perfoemance Scc	1									
Team Rank	-0.159	1.000								
Failure Perception	0.207	0.202	1.000							
Team Performance Percept	0.169	-0.196	-0.008	1.000						
Task Relevance	0.072	0.043	0.041	**0.771**	1.000					
Task & Goal Clarity	0.111	-0.057	-0.151	**0.712**	**0.697**	1.000				
Individual Performance Prc	0.250	-0.194	-0.162	**0.699**	**0.470**	**0.585**	1.000			
Relenting	0.044	0.083	0.155	-0.123	0.029	**0.033**	-0.164	1.000		
Persistance	0.042	0.055	**0.312**	0.019	0.209	0.107	-0.096	**0.718**	1.000	
Academic Response to Fail	0.123	0.003	-0.213	-0.227	-0.269	-0.042	**0.538**	-0.079	-0.153	1.000

Year 3

	Individual Perfoemance Score computed by game	*Team Rank*	*Failure Perception*	*Team Performance Perception*	*Task Relevance*	*Task & Goal Clarity*	*Individual Performance Prception*	*Relenting*	*Persistance*	*Academic Response to Failure*
Individual Perfoemance Scc	1.00									
Team Rank	-0.09	1.00								
Failure Perception	0.16	-0.03	1.00							
Team Performance Percept	0.14	-0.14	-0.09	1.00						
Task Relevance	-0.02	-0.02	0.12	**0.51**	1.00					
Task & Goal Clarity	0.03	-0.11	-0.04	**0.62**	**0.69**	1.00				
Individual Performance Prc	-0.01	**-0.36**	0.08	**0.75**	**0.33**	**0.63**	1.00			
Relenting	0.00	-0.07	0.05	0.19	0.12	0.05	**0.25**	1.00		
Persistance	-0.12	-0.08	0.08	-0.12	0.10	0.01	0.05	**0.71**	1.00	
Academic Response to Fail	-0.19	**-0.34**	0.21	-0.07	-0.12	0.20	**0.61**	0.15	0.22	1.00

Year 5

	Individual Perfoemance Score computed by game	*Team Rank*	*Failure Perception*	*Team Performance Perception*	*Task Relevance*	*Task & Goal Clarity*	*Individual Performance Prception*	*Relenting*	*Persistance*	*Academic Response to Failure*
Individual Perfoemance Scc	1.00									
Team Rank	-0.03	1.00								
Failure Perception	-0.03	0.21	1.00							
Team Performance Percept	0.03	-0.27	-0.27	1.00						
Task Relevance	0.02	-0.09	-0.09	**0.79**	1.00					
Task & Goal Clarity	0.08	-0.06	-0.05	**0.67**	**0.84**	1.00				
Individual Performance Prc	0.08	-0.36	-0.24	**0.77**	**0.57**	**0.62**	1.00			
Relenting	0.01	0.00	0.21	-0.10	-0.04	-0.06	0.03	1.00		
Persistance	0.07	0.00	0.26	-0.24	0.00	0.01	-0.16	**0.71**	1.00	
Academic Response to Fail	0.06	-0.14	0.03	-0.27	-0.27	-0.03	**0.41**	0.19	0.11	1.00

Table II. INDIVIDUAL PERFORMANCE VS. LEADERBOARD

Team Name	**Individual Performance computed by game**			**Total**	**Leaderboard Rank**		
	Year 1	Year 3	Year 5		Year 1	Year 3	Year 5
team-10	2460	4084	3812	**10356**	11	1	1
TEAM-2	2608	3168	3472	**9248**	7	3	2
CODERED11	2376	3756	4068	**10200**	6	6	3
APPLE3	3064	3336	4424	**10824**	4	7	4
COBRA-12	3096	3408	3804	**10308**	3	4	5
ALBATROSS-1	2724	2916	3752	**9392**	5	8	7
HOTWHEELS-8	2360	3208	4124	**9692**	9	9	8
PEGASUS-Corp	2332	3528	3336	**9196**	8	10	9
WAYNETEAM6	1668	3164	4628	**9460**	12	11	10
Zybo	2860	3640	3244	**9744**	2	5	11
RAVSS-07	2332	2340	3000	**7672**	10	12	12

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