Fish Bank ILE: An Interactive Learning Laboratory to improve understanding of "The Tragedy of the Commons"; a common behaviour of complex dynamic systems

QUDRAT-ULLAH[1], MOHAMED M. SALEH, BAHAA E. A. MOHAMED
(qudratu@ifi.uib.no) (mohameds@ifi.uib.no) (bahaam@ifi.uib.no)
Department of Information Science, University of Bergen, Norway

Abstract

In this work, an Interactive Learning Laboratory, based on Fish Bank Ltd., (A board game developed by Dennis Meadows) has been developed using the software Powersim™. The Fish Bank ILE, is an asymmetric game, having two distinct roles, one for the facilitator and other for the players. The main objective of this effort is to provide the users with an opportunity to better understand "The Tragedy of the Commons", a common behaviour often encountered in managing the complex dynamic systems; to illustrate for them by way of experiments how competitive behaviour can destroy renewable resources and that the negotiation between them, required to facilitate an improvement, is a challenging task. The players are exposed to a few tests, designed to measure the learning effects. This article also, describes the implementation of Gagne's instructional events in the design of the Fish Bank ILE.

INTRODUCTION

The "**Tragedy of the Commons** "is a situation which always opens with people benefiting individually by sharing a common resource e.g., Ground Water, Forests, Soil, Game Animals, Ozone or a Fish Area. But at some point, the amount of activity grows too large for the "commons" to support. In many cases, the "commons" seems immeasurably large and bountiful at first, but it is either non-renewable or takes a great deal of time and effort to replenish. When you have a "Tragedy of the commons" situation, the system is sending you a signal that "you" cannot solve the problem by your own, in isolation from your fellow competitors, users, or consumers. Typically this signal comes in the form of increased difficulty in getting "your" share of the common resource. Sometimes you can recognise it by your feeling of powerlessness. You and others around you then act even more aggressively, which of course accelerates consumption of "the common" and lead to the "crash" dynamics- the destruction or degeneration of the commons ability to regenerate itself. To better understand such issues i.e., the behaviour of complex dynamic system, the use of

[1] for correspondence (Sr. Scientific Officer, CHASNUPP, P. O. Box 1133, Islamabad, Pakistan)

Management Flight Simulators and Interactive Learning Environments (ILEs) has increased significantly over the last few years. Especially, the system dynamics based ILEs are in high demand; a significant amount of activity is taking place in this area [Lane, 1995]. However, some researchers [Sterman,1995;Lane,1995] have equally identified certain cautions and caveats about the design and applicability of these SD-based ILEs. This also includes the need to incorporate explicitly the relevant learning principles e.g., those mentioned by Robert Gagne [Gagne, 1995]. This paper describes the design and developments of such a SD-based ILE, in the light of described caveats and the incorporation of some "learning principles" in the design of the ILE; Fish Bank ILE.

PURPOSE AND AUDIENCE OF "FISH BANK ILE"

The prime purpose of Fish Bank ILE is to provide the players an opportunity (through experimentation with their strategies) to improve the understanding about " The Tragedy of the Commons "; a common phenomenon often encountered in managing the dynamical systems whereby the competitive behaviour of individuals, sharing a common limited resource destroys that resource eventually. Secondly, to show the players/ actors of the system how does the negotiation process needed to convince them that their competitive behaviour will lead to the catastrophic end for all, is a challenging task. Last but not least the purpose is to get involved the players /users to obtain the feeling that system dynamics based interactive learning environments (ILEs) are effective tools for better understanding such complex problems in real world. The students, both undergraduate and graduate, and the managers (juniors and middle level), are the intended audience of this ILE. They are supposed to have common basic calculational skills.

A WORD ABOUT "FISH BANK ILE"

Overview: The "Fish Bank ILE, a network game, is developed using the software Powersim™ (Version 2.5 C). At present, three players, the facilitator, and the observer/ s can participate in the game (in addition there is a "simulated-player" whose purpose is to set up scenarios). The game is asymmetric due to the different roles of the players and the facilitator. The facilitator, through his/ her interface, records the "ship-trading" after the players have done the negotiation regarding the sales and / or purchases of ships. These entered values will update the player's revenue and ship stock accordingly. Each player manages a fishing company for an assumed period of 25 years. Each company begins with some assets (bank balance and ships). The fishing fleet of a company is expanded through ship construction (through new ordering) and the buying of ships (through

trading), and reduces only through the sales of ships. The revenue is generated through fish-catch and sales, and the sales of the ships, while the fishing cost, harbour cost, ship construction, and ship buying incur the expenses. The fleet utilization decision impacts the revenue of the company accordingly. The target of the company is to "maximize the profits"; in line with real world business.

Workshop Setting: We believe that learning does not occur only just playing a game, but a workshop setting in which the players, besides playing participate actively in the relevant off-line activities. Towards this end, the major activities in the "Fish Bank ILE" workshop include a briefing session, a pre-play test, on-line game playing, a post-play quiz, and finally the de-briefing session.

Roles: The facilitator role involves both on-line and off-line activities. As an on-line player, he has to record/ input the ship trading (values) through his/ her interface panel. These entries will influence the stock of ships and total profit of the corresponding player. Towards the off-line activities, he/ she has to perform the briefing session, conduct the pre-play test, provide technical assistance, act as an advanced learner, facilitate the negotiation process, arrange the post-play quiz, and finally go through the de-briefing session. The players' on-line decisions include the construction of ships, the selling and/ or buying of the ships, and utilization of the ships in each time step. Of course, the test accomplishment, active participation in the briefing and de-briefing sessions is the essential part of his/ her role. The observer can view/ analyse the individual performances, and/ or total industry performance through the relevant information, made available via the observer interface.

DESIGN OF "FISH BANK ILE"

Model: The underlying model of Fish Bank ILE is based upon the simplified and modified version of Fish Bank Ltd.; a board game developed by Dennis Meadows. However, this simplicity does not compromise significant structures of the system, needed to reproduce the reference behaviour. The details of the model can be found in the extended version of this paper.

Incorporation of Learning Principles: According to cognitive theorists, "learning is composed of the reception, short-term storage, encoding, long-term storage, and retrieval of information". Gagne [Gagne, 1995] advocates that the nine external instruction events i.e., gaining attention, informing listeners of the objective, stimulating recall of prior knowledge, presentation of content, providing "learning guidance", eliciting performance, providing feedback, assessing performance, and enhancing retention and transfer, can effectively trigger the internal learning processes. An effort has been made to incorporate these instructional events in the design of "Fish Bank ILE", so as to

advance affirmatively towards the goal: "improve understanding- promote learning" about the underlying issue. In Fish Bank ILE, the player, at the very first screen/display, is presented with a "challenging task" with the help of "text window" and background pictures of relevant scenes, to grab his/her *attention* and arouse interest and curiosity. The *objective* is presented in clear terms; " How does the tragedy of the commons occur?". Also the briefing session contributes to these events. The "pre-play test" helps stimulate recall of prior knowledge. Text and objects are used in Fish Bank ILE for *material presentation*, a forth instructional event. This ILE embodies two runs. After the first run, the players are lead to an explanation interface, where they are presented with a generic causal-loop diagram together with examples as a *guidance for learning*. The navigational buttons of the ILE allow the player to go back and forth from generic to specific explanation and vice-versa: facilitating the *performance elicitation*. This explanation interface also facilitates the analyse of the players' case, proving the *feedback* before the 2nd run. Also, the pop-up window messages provide feedback to players such as. The post-play test is designed *to assess the performance* of the player. In Fish Bank ILE, the understanding of "the Tragedy of the Commons" systems archetype generates the useful insights applicable to other real world situations. The de-briefing session of this ILE will augment the last instructional event; *enhancing retention and transfer of knowledge*. In this way, the design of the Fish Bank ILE helps us accomplish the double-loop learning process on the player's part; a player learns first by playing interactively and then the insights gained, all the way through the de-briefing session, will help him change the mental models that will result in new decision making :*a double-loop learning*.

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