Workshop: Hands-on Sampling of Experiential Learning Modules that Promote AI Competency Across STEM Disciplines

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2022 IEEE World Engineering Education Conference (EDUNINE) | 978-1-6654-8336-0/22/$31.00 ©2022 IEEE | DOI: 10.1109/EDUNINE53672.2022.9782374

***Abstract*—Western Michigan University, together with public and private partners, have developed ten learning units that promote artificial intelligence (AI) competency across STEM disciplines. The learning units are modular, experiential, customizable, and fun to use. They have been developed for both traditional classroom and self-directed learning. The modules are loosely coupled, so that learners can choose different pathways and modes of usage to suit. With an emphasis on "learn by doing", the modules are experiential and can be customized for different STEM disciplines. The primary aim of the proposed workshop is to provide participants with hands-on experience of the learning units for themselves and go through a guided journey of discovery that is fun and engaging. An integral part of this dissemination effort involves a "train the trainers" component, encourages participants to share their experiences among others in their workplaces, etc., thereby creating a multiplier effect.**

***Index Terms*—STEM education, artificial intelligence, 21st skills development, hands-on activities, experiential learning**

I. Introduction

Members of the Transformative Interdisciplinary Human + AI Research Group [1] at Western Michigan University, together with public and private partners, have been engaged in a research project that involves the development of ten learning units to promote artificial intelligence (AI) competency across STEM disciplines. The research group is led by computer science (CS) researchers and has members from several quantitative disciplines, such as statistic, business analytics, and branches of engineering (especially civil, mechanical, and electrical). A common thread that binds all members of the group is a shared interest in promoting and applying safe use of AI technologies to their respective fields.

The learning units are modular, experiential, customizable, and fun to use. They have been developed for both traditional classroom and self-directed learning. The modules are loosely coupled, so that learners can choose different pathways and modes of usage to suit (e.g., in class for one module and self-learning for another). With an emphasis on "learn by doing" and usage of relevant data/use cases, the modules are experiential and can be customized for different STEM disciplines. Examples of non-CS STEM uses include dynamic modeling for statisticians [2], smart cities [3], business decision and planning [4], vehicle drive cycles [5], etc.

The proposed workshop aims to provide participants with hands-on activities to experience the learning units for themselves. They will embark on a guided journey of discovery that is fun and engaging. An integral part of this dissemination effort is a "train the trainers" component, whereby participants share their experiences among others in their workplaces, etc., creating a multiplier effect. The rest of this short workshop proposal is organized as follows. Section II presents an overview of the project. Using Module 2 as an example, Section III describes learning activities, planned interaction, and duration. Finally, Section IV concludes the paper with a short biography of the lead presenter.

II. Overview

A. Flexible Framework

The overall framework is designed to be flexible and adaptable. Currently, it consists of three loosely defined levels of training suitable for the following groups of learners:

1) Foundational: Undergraduates in CS 1 and CS 2 and high school students with some computing background.
2) Intermediate: Undergraduates in 3- and 4-level classes.
3) Advanced: Undergraduates and graduates taking 5- and 6- level classes, and practitioners who use AI.

Note that these are not strict divisions. For example, it is possible for advanced students to benefit from modules

The work described herein is supported by US NSF under grant 2017289.

intended at a higher level. The loose coupling of modules means that it is not necessary to follow any specific sequence. Table I summarizes ten initial modules. The flexible framework facilitates future expansion.

TABLE I
INITIAL LEARNING MODULES

M#	Title	L[a]
1	Math Toolkit for SSR AI	F
2	Algorithmic Exploration & Exploitation of AI's weakness	F
3	Modular & Structured Software Development for SSR AI	F
4	Data Structures for SSR AI	I
5	Deep learning with HPC	I
6	SSRAI Software Development for HPC deployment	I
7	Vulnerabilities of Statistical Machine Learning	A
8	Beyond current generation AI	A
9	Adversarial ML and Robust Trust Scoring Models	A
10	Societal Impact of AI	A

[a]Level = **F**oundational, **I**ntermediate, or **A**dvanced.

B. Module Design

Each module is designed using a recommended format. Deviation from the recommendation is possible.

1) Introduction
2) Guided exploration
3) Implement an instance of an issue to gain insight
4) Develop a countermeasure based on set goal and issue (solving in principle)
5) Implement and evaluate the countermeasure (solving in practice)
6) Reflect on the outcome

III. Detailed Description

There is an expectation that, at least initially, the workshop will focus on the foundational modules. This section describes a module in details to illustrate. It is important to note that the suggested times are for a learner to be fully immersed in the experience. Workshop participants will likely instead sample multiple modules/segments.

Module 2 (foundational) Algorithmic Exploration and Exploitation of an Intelligent System's weakness
Background: Learners need some basic programming skills expected of a typical STEM freshman.
Segment 1 (typically 30 minutes to allow for two-way dialog): Introduction by trainer. Outline: Define intelligent system as software that is designed to exhibit rational behavior. Illustrative examples, e.g. high-profile breaches, will instill awareness of weaknesses of such systems.
Segment 2 (typically 2 hours): Guided exploration. Learners will explore the field and identify one possible weakness of intelligent systems that can be exploited. With exposure to basic search algorithms, the intelligent system is a rational agent that attempts to solve problems using a uniformed search algorithm, e.g. an agent that offers navigational advice from City A to City B or a web spider that is tasked with crawling the web.
Segment 3 (typically 2 hours): Guided exploitation. Learners at this level will have limited CS knowledge; they will be provided with resources to enable them to exploit a possible weakness of an intelligent system. For example, they can attempt to lead a search algorithm into redundant search paths and/or infinite loops or design a trap algorithmically for the web spider. Thus, learners gain experience that weaknesses can be exploited even with limited knowledge and resources.
Segment 4 (typically 2 hours): Learners will be asked to formulate possible ways to mitigate the identified weakness. For example, they might suggest the introduction of guards against spider traps and might offer an outline of a possible algorithmic solution.
Segment 5 (0 hours): Implementation of a countermeasure is not articulated in this foundational module.
Segment 6 (typically 1/2 hour): Learners will reflect on the whole exercise and discuss their experiences. This activity will help learners to moderate and consolidate their newly gained knowledge and awareness.

Students who major in other STEM subjects, e.g. engineering, often take elementary CS1 and CS2, and they can benefit from Modules 1 and 2. These foundational modules can be offered to business students and even industry partners as "SSR AI 101" self-directed learning unit. In future outreach activities, variants of these modules can also be offered to motivated high school students at summer camps, etc.

IV. Conclusion

This short workshop paper has highlighted on-going research that involves the development of easy-to-apply learning units aimed at helping diverse STEM learners gain AI competency. Instead of focusing on the benefits of AI, the modules take a more measured approach by guiding learners through both strengths and weaknesses of AI. The proposed workshop aim to disseminate this project broadly at a prominent venues so researchers and educators can consider adopting some of the learning units and practices for their applications.

A. Main Presenter's Biography

Alvis Fong has extensive research and consulting experience in AI/ML. He has a history of developing technology-enhanced learning, e.g., personalized learn-on-demand system. His research outputs include 2 books, 14 book sections, 211 papers, and 2 patents. Dr. Fong holds four degrees in EE and CS. He is a European Engineer (Eur Ing) and Chartered Engineer (CEng).

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