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Short Paper: Immersive and Diversified Artificial Intelligence Education

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Abstract. The world endured drastic change recently. The emerging and innovative technologies will make the societal and industrial transformation exponential in the foreseeable future. A question proposed to universities is how to create innovative educational programs that not only deal with the emerging challenges, but more importantly, lead the digital transformation by inspiring and cultivating the future leaders in the fourth wave of the industrial revolution. The major challenges of AI teaching-learning include the following: a) Managing the extremely diverse backgrounds and experiences of the students within the same cohort; b) Imparting skills in an area that has too many subtopics, many of which are open-ended, and with little hierarchy; and c) The requirement of sufficient practice in solving real-world problems from end-to-end. Addressing these challenges, the proposed paradigm of Immersive and Diversified Artificial Intelligence Education (IDAIE) will integrate the following educational practices: 1. pre-assess the capabilities of students to develop a customized study plan to achieve the optimal learning outcomes for each student. 2. Utilize ‘minds-on and hands-on’ loop to reinforce understanding and solidify gained skills. 3. Offer a mini project/hands-on activity every week outside of the classroom to enhance implementation ability. 4. Check their self-reflective pieces and frequently interact with them for open discussion in multiple aspects, i.e., cognitive, psychological, experiential, etc. 5. Encourage the students to self-design open-ended course projects based on their learning curves. 6. Engage community partners and collaborators with the provision of a variety of community/industry projects for students’ participation. This endeavour demonstrated a way to cultivate students’ practical abilities to build a complete artificial intelligence system from scratch. It is noticeable that IDAIE does not mean to diminish the importance of theoretical knowledge learning. It is aimed to incorporate theoretical knowledge learning into practices. This pedagogy can also be applied to AI-related courses and other technical engineering courses.

Keywords: Artificial Intelligence Education, Minds-on and Hands-on, Self-reflective.

1 Introduction

Artificial Intelligence (AI) has been contributing essentially in the societal and industrial transformation towards a more perceptive globe [1-7]. With the prosperity of Deep Learning and related advances in recent decade, for both fundamental research and applications, the educational innovation in undergraduate and graduate levels have been essential to meet the ever-changing needs of industry and communities [8-12]. Usually, the traditional Artificial Intelligence Education (AIE) follows the pattern of a regular STEM course. Here are the main outlines for the barriers if AIE is conducted in a conventional way:

1. It focused more on the theoretical aspects that fail to connect the theory with practice.
2. The design of evaluation modules usually do not adequately consider the diverse backgrounds of the students. In the context of 'AI for Everyone', it is quite possible that students with various majors are registered in the same course and the same section.
3. Community engagement is normally not in place. Specifically, it is difficult to engage the local SMEs or the co-op employers for course projects.
4. It is difficult to convert an integral course into microcredentials that meet the demands of professionals for reskilling and upskilling.

Therefore, it is necessary to propose a novel educational frame aiming at addressing current pain points, forming the motivation of the proposed Immersive and Diversified Artificial Intelligence Education (IDAIE). IDAIE provides educators and instructors guidance and a detailed solution for implementation. It is noticeable that the proposed idea is not confined to the educational practice of AI, but is also applicable to other engineering-related curriculums or courses.

In the following sections, the authors break down the framework of IDAIE in terms of several major features/functionalities. Then, the overall discussion will be made to revisit the entire paradigm with the innovation of grading scheme as a gateway.

2 IDAIE for Community Engagement

Community Engagement is featured in the idea of IDAIE. When applying IDAIE for an AI course, students will have good exposure to a few open-ended course projects that are proposed by valuable community partners. These projects can be continued in their capstone (for undergraduate students) or graduate research (for graduate students).

By participating in community-engaged projects, the following learning outcomes can be achieved.

1. Build the capabilities of leadership, teamwork, communication skills, and interpersonal relationships.
2. Comprehend the general process and elements of community/industry project design and implementation, i.e., empathize, define, ideate, prototype, and test.

3. System design of a comprehensive or multiple-disciplinary project that is comprised of disruptive techniques underneath the framework of IDAIE.
4. Build and enhance workplace skills such as leadership, teamwork, communication skills, and interpersonal relationships.
5. Build expertise in designing and optimizing systems using various advanced technologies of AI systems to leverage the value of the community/industry project.
6. Understand the importance and necessity of team building and project management, including time management, for complicated technical designs.
7. Decompose a complex system into subsystems for function building, analysis and problem solving; integrate subsystems to test overall functionality and performance.
8. Proactively approach community/industry partners and faculty leads to advance the progress of project development.
9. Capable of writing proposals and project reports to clearly convey, ideas, plans, and results with sophisticated and accurate professional language and good formats; Capable of presenting clearly in different stages of project design and implementation.

3 IDAIE for Microcredentials

The definition of Microcredentials is beyond short courses [13]. It represents a future trend of learning with the following features.

- 1) It redefines the learners' success and the motivations for educators.
- 2) It emphasizes the importance of educators themselves for improving the competency and seeking more collaborations.
- 3) It is tailored with a learner-centric approach to support the learners' career path and enrich their learning experience.
- 4) It is aligned with a more flexible curriculum.
- 5) The provision of a variety of delivery modes and accommodations is available.
- 6) The communities are well engaged. The learning outcomes are not only beneficial for learners, but also for community partners.

The proposed idea of IDAIE has a natural compatibility of microcredentials. As an example, to implement microcredentials for a three-credit course, one could consider converting it into three one-credit successive sections. Both the current students and the professionals can be involved in these sections. The delivery modes will be provided with multiple approaches, including in-person, online, remote, or hybrid. The learners choose one of the delivery modes or a combination of them to attend the class. This provides the learner the maximal flexibility to fit their individualized schedules. After successfully completing any of the sections, a microcredential certificate of that section will be issued. Once the learners pass all sections, a course certificate will be issued. These certificates are probably more valuable compared to the grades on transcripts for job hunting.

When converting an integral course into multiple microcredential sections, one of the major challenges is to redesign the assessment schema. This issue is discussed in detail in Section 5.

4 IDAIE for Everyone

In this age and in the foreseeable future, AI will play an essential role in industry, healthcare, service, and policy making. Therefore, the accessibility of AI education will be granted for the maximum backgrounds of learners, with a variety of levels. However, due to the limited teaching capacity of any institution, it is not realistic to distinguish the learners based on their background and level of competencies. The problem can be addressed by applying IDAIE, which encourages the instructors to mix students with different backgrounds within the same class. By doing so, it allows the students to learn from their peers. Besides, the community projects are usually multi-disciplinary. This positions a group of students with various majors to excel in these projects.

Taking the community engaged project of *wound healing prediction* as an example. With the growing population of patients with complex wounds, it is challenging for healthcare organizations to manage ulcers and lesions from diabetes and pressure sores. To combat the impact of the chronic wound imposed on the healthcare system, it is necessary to optimize one of the critical treatment processes – wound monitoring and assessment. The current wound segmentation techniques can be categorized into two major groups, deterministic and stochastic. The deterministic approaches rely on the knowledge of the wound, such as the colours and the shape of wounds in image segmentation. Unlike the deterministic approach to wound segmentation, the stochastic approaches require less prior knowledge of wounds and focus on the training of deep neural networks. This approach often impacts the quality of input data but is robust to empirical risk if the model is well-trained. Such kind of project needs a diversified team to address the open-ended challenge of the accuracy of the wound and to automatically identify the wound area in the wound treatment process.

5 Revisitation of IDAIE by Re-Designing Grading Scheme

With regards to the content, the basic learning outcomes include: 1) the learners shall comprehend classic AI approaches as well as newly emerging techniques such as Convolutional Neural Network, Transformer, Recurrent Neural Network, and Generative Adversarial Network; 2) the learners shall be capable for integrating theory with practice to enhance their transferable skills; 3) the learners know how to apply AI in the real world by using advanced techniques or tools; 4) the learners are capable of designing and optimizing the performance of AI models for addressing the real-life headaches; last but not least, the learners shall be educated with a high level of ethics and integrity to use AI for good purposes only, i.e., the brighter future of humankind and the sustainability of natural environment.

To make the grading scheme compatible with multiple microcredential sections mentioned in Section 3. The gradeless model, called the *Residency Model* of education in our program. A sample assessment schema in this model is as follows:

- 1) Quizzes
 - Each quiz will be open for a week, unlimited attempts, must get 100%
 - For unofficial grade – pass = 1, fail = 0

2) Hands-on Projects (2)

- Each project has multiple steps to accomplish.
- Each step will be graded as *satisfactory (S)*, *unsatisfactory (U)*, *exceeds expectations (E)*.
- To pass each hands-on project –
 - At least 70% of all steps must have a *S* grade or *E* grade.
 - For unofficial grades: U = 0, S = 1, E = 2

3) Midterm Portfolio

- Contains two challenging projects plus one-page reflective piece that talks about methodologies and techniques learnt in the course.
- Each project has multiple steps to accomplish.
- Each step will be graded as *satisfactory (S)*, *unsatisfactory (U)*, *exceeds expectations (E)*.
- To pass the midterm –
 - At least 70% of all steps must have a *S* grade or *E* grade.
 - At least get *S* grade for reflective piece
 - For unofficial grades: U = 0, S = 1, E = 2

4) Course Project

Part 1. Project info sheet, with tentative project title, and short description of project.

Part 2. Project presentation - about 30 minutes (Q/A inclusive) per group.

Part 3. Source code - well commented and bug-free, plus the appendix such as dataset if needed to run the code.

Part 4. Video demo - showed the implementation process of the project.

Part 5. A comprehensive written report.

- *Each step will be graded as satisfactory (S), unsatisfactory (U), exceeds expectations (E).*
- To pass the Course Project –
 - At least get S for all parts.
 - For unofficial grades: U = 0, S = 1, E = 2

5) Final Portfolio

- A 2-3 page reflective piece that talks about methodologies and techniques learnt in the course contextualized with the course project and other project modules that the student completed through the course.
 - For unofficial grades: U = 0, S = 1, E = 2
- One challenge project
 - For unofficial grades: U = 0, S = 1, E = 2
- To pass the Final Portfolio –
 - At least get S for above two parts.
 - For unofficial grades: U = 0, S = 1, E = 2

The learner must pass all the modules to get the microcredential certificate. This grading scheme can be easily recovered with the regular grading models such as percentages or GPA scale like 4.0, since the instructors can keep the unofficial records of original grades.

6 Conclusions

There is a trend that the gap between humans and machines is increasingly narrowing in terms of intelligence. Sensing, communications, and computing embedded with ambient intelligence are at the heart of digital technologies, with rising applications in manufacturing, transportation, health, building automation, agriculture, and the environment. It is expected that the emerging technology clusters of Ambient Intelligence Computing will not only transform the modern industry, but, more importantly, advance societal health and wellness, and make the living environment of the globe more sustainable.

The proposed framework of IDAIE serves as a guide and a feasible approach to novel curriculum design. It is aimed to significantly transform undergraduate and graduate education to meet the high demand for AI applications in industry, healthcare, service, and public policy. This short paper addresses the principle of IDAIE in aspects of community engagement, microcredentials, diversified accessibility, and redesign of the assessment scheme. As a natural progression, this framework will be investigated in more detail. It must be noted that the idea proposed in this pedagogy is also applicable to other technical engineering courses.

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