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Artificial Intelligence to Enhance Learning Design in UOW Online, a Unified Approach to Fully Online Learning

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Abstract

The current article presents a framework for the design and support of UOW Online, an entirely new unified university strategy for fully online learning. To aid teachers in the learning design process, we aim to create more awareness for teachers by determining the underlying learning design of their subject. To ensure the approach can be scaled up to cater for potentially hundreds of subjects, the manual labeling serves as input for an Artificial Intelligence (AI) algorithm that will train a model to label intended learning activities automatically. In addition to student demographics and behavior, the learning design and subject content will be used to augment an AI model that predicts future student outcomes. Future work focuses on the collection of necessary learning activities and manual encoding of these learning activities.

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Artificial Intelligence to Enhance Learning Design in UOW: a Unified Approach to Fully Online Learning

Rory L. Sie, Janine Delahunty, Kenton Bell, Alisa Percy, Bart Rienties, Trinh Cao and Maarten de Laat

Abstract— The current article presents a framework for the design and support of [removed], an entirely new unified university strategy for fully online learning. [Removed] core pedagogical principles puts students at the centre of learning, promoting discussion through networked learning and a dialogic approach, and providing multiple opportunities for peer support and reflection. To aid teachers in the learning design process, we aim to create more awareness for teachers by determining the underlying learning design of their subject. To ensure the approach can be scaled up to cater for potentially hundreds of subjects, the manual labelling serves as input for an Artificial Intelligence (AI) algorithm that will train a model to automatically label intended learning activities. It is widely acknowledged that student demographics and behaviour are just two main factors that influence student success. Perhaps less understood is the impact that learning design has on student performance in specific contexts. Therefore, in addition to student demographics and behaviour, the learning design and subject content will be used to augment an AI model that predicts future student outcomes. Future work focuses on collection of necessary learning activities and manual encoding of these learning activities.

Keywords— artificial intelligence, learning design, online learning, networked learning

I. INTRODUCTION

The [removed] is a 'young and vibrant' university that prides itself on offering personalised experiences and outstanding learning environments. [Removed] is a research-intensive university, providing state of the art facilities and innovative leaders and pioneers of world-renowned research. In keeping with the university's purpose and vision, [removed] strives to equip students with diverse skills, experiences and networks, which are fundamental to becoming socially connected leaders and collaborative contributors to their communities and workplaces. This is reflected in the rankings from the Quality Indicators for Learning and Teaching [1], which show that overall, [removed] was [removed] for the undergraduate experience. The postgraduate experience was also ranked highest in [removed].

Trend studies in higher education (HE) indicate a changing (or broadening) HE student profile and an increase in demand for self-directed and collaborative teaching and learning arrangements based on personalised and flexible learning needs. In the provision of higher education qualifications, Altbach, Reisberg and Rumbley [2] highlight the need to "focus on lifelong learning and ongoing professional education and

(re)training - to provide real flexibility in teaching and learning within higher education" [p. 136]. The aim of providing such flexibility, particularly within distance modes of learning, is to allow greater access to ongoing education and qualifications for diverse cohorts of students who are also balancing work and life commitments, or who may be living and working in regional and remote areas [2]. The vision for [removed] is to grow into a competitive player in the online global higher education marketplace. The primary goal is to provide an interactive, engaging environment for students to undertake wholly online degrees, commencing with a number of postgraduate courses [3].

It is part of [removed]'s strategic initiative to enhance our global networks, increase access and success in higher education, and provide flexible technology-enriched student learning experiences, anytime, anywhere. Consequently, it is apparent that the provision of high-quality online courses is necessary if [removed] is to meet its strategic priorities and maintain its research profile and strength in teaching and learning and employability. Through providing courses online, we aim to attract new students and grow our student enrolment numbers in general. Besides our campus-based offerings in [removed], the region, and offshore campuses, promoting delivery of courses online will help to spread the risks and stimulate diversified growth.

At an institutional level, the primary challenge we face in the shift from on campus (and blended) deliveries of postgraduate courses to wholly online modes of delivery, is how to sustain equivalence in the quality of the online teaching and learning experience. This challenge is complex and encompasses the development of a range of strategies to support the academic development of teaching staff, including online pedagogic principles, sound design for online learning environments, and understanding the relationships between these and student outcomes. To address the challenge, we aim to develop principles for online pedagogies underpinned by complementary theoretical approaches, which foreground activity and interactivity as core to the online learning experience. From this position, learning design is approached not in terms of content, but rather as opportunities embedded in the design for student (inter)activity across a course or subject.

In our approach, the intended learning activities (as designed by the teacher) will be manually labelled according to a learning activities' scheme developed by Conole [4]. The set of intended learning activities and associated learning activity categories

will be fed into an AI algorithm for training. Subsequently, the AI model can be used for automatic categorisation of intended learning activities. This approach allows for large-scale automatic labelling of intended learning activities, which will help save valuable time that educational designers can use for other activities, such as working closely with teachers and giving them feedback.

In this paper, we provide some of the contextual background, which situates the particular challenge of equivalence in quality of teaching and learning when shifting to fully online postgraduate courses from an institutional level perspective. In the next section, we discuss the theoretical background and introduce the three key concepts which underpin the pedagogic principles we have developed for online learning [3], followed by a description of learning design and the use of artificial intelligence in education [5]. Finally, we discuss how artificial intelligence can be used to enhance learning design. In our concluding comments, we propose future collaborative work to be undertaken.

II. THEORETICAL BACKGROUND

To better understand the impact of learning design on student success in an online learning environment, it is necessary to ensure that the design is grounded in learning theory. It is particularly important that the environment offers students the same or better affordances of campus-based learning. This includes high-quality standards of teaching, feeling 'at home' in the online environment, experiencing the freedom and motivation to express themselves, freely discuss ideas in order to grow and learn with a group of peers. The following sections detail the pedagogical principles that are fundamental to our approach.

A. Networked learning

For online design to be effective consideration needs to be given to connectedness. Connectedness is at the heart of networked learning — connecting to ideas, people, and resources for learning. Networked learning recognises that learning is fundamentally a social activity and that the learning environment must provide a multitude of affordances to capitalise on the learning value of social exchange [6]. McConnell, et al [7] suggest that designing for networked learning involves attention to six broad principles: openness in the educational process and the building of a learning community; self-determined learning and the affordances provided for students to take control of their learning; a sense of authentic purpose in the cooperative process; a supportive learning environment that involves both intellectual challenge and peer support; collaborative self-peer-tutor assessment of learning; and formative and iterative evaluation and shaping of the learning design during the process of study.

The importance of community cannot be understated. Dynamic online and networked communities require ongoing explicit and visible social, cognitive and teaching presence for both the teachers and students to feel engaged and connected to each other and the learning process [8, 9]. A strong and active presence fosters relationships that help learners establish rich

networks, readily share knowledge, and gain access to ideas, resources and experiences they would not have access to in sites with minimal presence. These communities could be seen as their home, building a safe and trusting environment for group support and learning.

B. Dialogic approach

Facilitating a networked learning approach cannot be achieved unless social interaction and dialogue are at the centre of the design. Dialogue enabled through social interaction which drives effective online learning and facilitates 'education for dialogue and not simply education *through* dialogue' [10, p. 14]. Meaningful conversations between students, teachers, and a wider network of professionals make learning personally relevant, reflective, and is seen to foster active participation based on a stronger sense of shared ownership [11]. Learning in networks through social interaction and dialogue involves sharing interests, experiences, and questions [12], as the participants co-produce knowledge, and develop the skills and competencies outlined in the course goals. This process is closely guided and moderated by teachers and tutors, who will often act as peer learners in these conversations.

To successfully embed a dialogical approach, there must be an investment in social interaction, specific activities that foster the development of thinking, dialogic skills and academic literacies, and the frequent use of group presentations and peer assessment. From a technological perspective, teachers can now receive support in the form of automated discourse analysis [13, 14], which may provide an unbiased observation of how dialogue evolves in the online space. It is part of a multi-method approach to understanding networked learning [15] where social network analysis [16], content analysis [13, 14] and context analysis [17] are combined.

C. Active student-centred learning

Active student-centred learning can best be achieved when social interaction and dialogue lay at the centre of the design, where students are invited to take ownership of their learning and engage in sensemaking activities with their peers. Design for active student-centred learning therefore, must ensure that tasks are relevant to expressed student interests and motivation. In contrast to teacher-centred approaches [18], and as a way of contributing to intrinsic motivation through *autonomy* and *relatedness* [19], students can be invited to lead discussions, articulate their own learning needs, share their reflections on their learning journey, and actively produce content as a way of turning their experience into knowledge [20]. Group activities around the identified learning needs can be designed using the pedagogical strategies of inquiry [21]. Some of these strategies may be used to promote and embed peer learning and tutoring and allow for student assessment and marking of each other's work [22, 23]. In this way, students are learners and tutors at the same time; and there is guidance of student learning and promotion of peer reflection and support [24]. As part of this sensemaking process, students can bring in experiences and find new content, resources and build connections with existing networks and communities [25].

Category	Description	What students are expected to do	Sense-making activities (helping Assimilative to Assessment)
Assimilative	Attending to information	read, watch, listen, think about, access, observe, review, study	
Finding and Handling Information	Searching for and processing information	list, analyse, collate, plot, find, discover, access, use, gather, order, classify, select, assess, manipulate	
Communication	Discussing module content with at least one other person (student or lecturer)	communicate, debate, discuss, argue, share, report, collaborate, present, describe, question	
Productive	Actively constructing an artefact	create, build, make, design, construct, contribute, complete, produce, write, draw, refine, compose, synthesise, remix	
Experiential	Applying learning in a real-world setting	practice, apply, mimic, experience, explore, investigate, perform, engage	
Interactive/Adaptive	Applying learning in a simulated setting	explore, experiment, trial, improve, model, simulate	
Assessment	All forms of assessment, whether continuous, end of module, or formative	write, present, report, demonstrate, critique	

Fig. 1. Adaptation to the learning activity categorisation proposed by [4, 31].

III. LEARNING DESIGN AND ARTIFICIAL INTELLIGENCE IN EDUCATION

A. Learning Design

While learning design is crucial in any educational context, it could be argued that it becomes even more so in online environments where the vast array of available technologies compete for attention and where the absence of physical presence can expose aspects of the design (good or otherwise). For example, in face-to-face teaching and learning the ability to share in an unfolding situation where people are co-present is often taken for granted, and flaws which might become evident in an “implicit, belief-based” design [4, p. 1] may be mitigated through the immediacy of a teacher providing further explanation or expounding or encouraging an impromptu discussion. This contributes to timely clarification and lessens the possibility of misunderstanding. Due to the lack of immediacy available in online learning, the potential for misunderstanding is increased. This can be mitigated through opportunities for dialogue and (inter)activity which need to be more deliberately designed and orchestrated. However, this can be challenging, as it requires teachers to shift their thinking away from content focus, towards design decisions that will encourage dialogic activity [26, 27]. Such shift requires a level of explicitness, which is not often needed in face-to-face teaching situations.

Conole [4] proposes Learning Design as a methodology for helping teachers (and developers) to make their design decisions explicit, and as a way of approaching the use of technologies in pedagogically informed ways. The Learning Design approach has a number of benefits: it acts as a means of eliciting designs from academics which can be reviewed by developers; provides a means for reusing designs as opposed to just sharing content; acts as a guide through the processes of creating learning interventions; creates an audit trail of

academic design decisions; highlights policy implications for staff development, resource allocation or quality; aids learners in complex activities by guiding them through the activity sequence [4].

In this paper, we focus on one aspect of Learning Design that can be readily implemented in our context. This is partly in response to some academic staff who are finding it difficult to shift from content-based to activity-focused delivery, which is essential for quality in online learning. A tool conceptualised by Conole [4] focusing on student activity in online learning provides a way of understanding learning design, provides a shared language for different stakeholders involved in the design-review-evaluation process, as well as making practice explicit by focusing on what students will be doing throughout their online learning experience [p. 13]. According to Conole and Wills [28], visualisation may be useful for guiding the teacher’s design thinking, making the design explicit, so it is shareable, and representing and articulating the design process [p. 27]. The visualisation tool has been developed and tested extensively at Open Universities UK [29-31] and in other higher education contexts (e.g., [29]).

The tool describes seven types of learning activity, including examples which foster a shared language and understanding of the design for all involved, provided below (adapted from [31, p. 237]). To introduce this in our context, and as a way of bridging Assimilative to Assessment activities, we view the middle five activities as contributing to the sensemaking process, which is crucial for learning (shown in Figure 1, Column 4). Finding and Handling Information and Communication relate to core processes involved in networked learning and dialogic approach, whereas Productive, Experiential and Interactive are associated with the active student-centred approach to ensure that learning activities remain relevant and motivating.

The visualisation of design involves determining the amount of time students are expected to spend on various activities guided by the categories and descriptors. Once all the activities have been categorised and timed, this is converted to percentages, generating a graph (Figure 2). The graph provides a tangible view of activity distribution across the subject/course, and is an important conversation starter for reviewing, evaluating and improving the learning design, and as a record of the various design iterations. While the benefits for teachers are clear in this process, it may be easy to assume better student outcomes will result from such attention to learning design. For us, this is an aspect which is relatively unknown and thus we propose that a better understanding of the relationship between learning design and student outcomes will be through making use of Artificial Intelligence in education, discussed next.

Fig. 2. A graph visualisation of learning design. Note that activities can have multiple learning design labels: and should not add up to 100%. Here, 50% of learning activities contain the label 'Assessment'.

B. Artificial Intelligence in Education

Artificial Intelligence has recently gained much attention due to dramatic improvements in computer vision [32] and natural language processing and generation [33, 34]. The former focus on how computers can distinguish objects, while the latter focuses on how a computer can understand and generate sentences. However, both use similar techniques from Artificial Intelligence, that is *Deep Neural Networks* or *Deep Learning* [35]. Although the exact implementation varies per problem, most deep neural networks use an input (e.g., cat images) and an output (e.g., classification whether this is a cat or not). If the output classification is known, a complex network comprising several layers of weights can be learnt by the computer to map the input to the output. Often, this is referred to as resembling the way the human brain processes input (e.g., a picture) to produce an output (e.g., recognition of a cat). In automatic text classification, such as semantic tagging, labelling or determining a sentiment, deep learning models have proven to be very effective [36, 37].

In the field of education, there has always been a slumbering interest in AI, given the International AI in Education Community (IAIED) that has existed for over 20 years, and the existence of an educational data-mining community since 2011. Traditionally, their focus has been on Intelligent Tutoring Systems that automatically model and assess learners, to provide them with automated, personalised feedback [38, 39]. More recently, the increase in computing power, the amount of data captured and the availability of AI algorithms to the general public (e.g., through scikit-learn for Python) made for a reignited interest in the use of AI in Education. AI is increasingly used to predict future grades [40, 41], sometimes with astonishing results (90+% accuracy) due to the use of deep learning [42].

However, the approaches above only use student demographics and student behaviour as the input data. It is well

known that student success does not solely depend on the student. Instead, it is influenced by a variety of factors, such as the context, the teacher and how well teachers connect among themselves [43], parental involvement [44], and the learning design [45]. This point is highlighted by Gašević et al. [46], who show that the instructional conditions, such as Learning Management Systems (LMS) use and thus the complex interplay of how resources are presented and how online assessments are designed, have predictive power with respect to student success. Building on these findings, we argue that in order to promote and predict student achievement, it is necessary to include learning design (e.g., intended learning activities) and subject content, which provide information about a) the teacher and his/her teaching methodology, and b) the specific context in which the learning design is implemented.

In addition, if we develop a model that maps learning design to student outcome, we can predict how learning design will affect student outcome, given a specific context. For example, if a subject's learning design is specified by learning activities Assimilative, Communication, Experiential and Productive, the student demographics and behaviour are known, and the student outcome is a pass rate of 90%, then the computer can create a model that identifies effective learning design, given a group of students in a specific context. The next time a subject is presented with learning activities Assimilative, Communication, Experiential and Assessment (note the change), the AI model can find the closest learning design that is effective in that specific context, and it will recommend that the Assessment learning activity be replaced by a Productive learning activity.

IV. USING ARTIFICIAL INTELLIGENCE (AI) TO ENHANCE LEARNING DESIGN

So how do we go about using AI to enhance learning design, and possibly promote student success? Firstly, AI techniques rely heavily on data. This data needs to be labelled for the computer to 'learn'. That is, we need data that consists of input variables, the pre-conditions (such as student demographics, subject content and the learning design), and their label variables (such as pass/not pass (dichotomous) or a grade (continuous)). Typically, the AI algorithm aims to determine a formula that can predict the label variable using the input variables (also known as *classification*).

However, we are not limited to only predicting pass/not pass, we can also use AI on labelled data about learning design categories (output variable) and the underlying intended learning activities. After all, the data contains input variables and associated labels that can be learnt by a computer. For instance, if the intended learning activity prescribes a student to 'read resource X', manual labelling may indicate that this is an 'Assimilative' learning activity. The computer can learn that every sentence that includes the words 'read' and 'resource X' are Assimilative. If this is true for all resources, it can even learn that just the word 'read' entails an assimilative activity. Naturally, this holds for other intended learning activities and manual coding of learning activity as well. Automating this

classification process opens up venues for large-scale learning design labelling of intended learning activities.

Our approach is identified by two phases. Firstly, Phase 1 (Figure 3) will commence with the collection of intended learning activities for multiple courses and subjects. The intended learning activities, paragraphs of text that describe learning activities, are then manually labelled by experts (e.g., a teacher in collaboration with an educational designer). Next, we will 'train' an AI model by feeding it with these text snippets and associated labels (classes), such that it can train a text classification model. Recurrent Neural Networks (RNN) with Long Short-Term Memory (LSTM) have proven to be effective at text classification, since they consider the sequential nature of text [36, 37], as do bidirectional Gated Recurrent Units (GRU) [CITATION].

Once the AI model is trained in such a way that it can accurately mimic human tagging, Phase 2 commences (Figure 4), which involves automatically labelling intended learning activities to learning activity categories. Together with student demographics and behaviour, it can then be used to train a model that predicts student outcome. Typically, regression, decision trees and Bayesian techniques are used to train a predictive model [47].

Fig. 3. The activities needed in Phase 1 to collect and label intended learning activities to train an AI model.

Fig. 4. The activities needed in Phase 2 to automatically label intended learning activities to predict student outcome.

V. CONCLUSION

The current article lays out the pedagogical principles for a unified, university-wide learning platform for postgraduate subjects that are taught wholly online. The underlying pedagogical principles (networked learning, a dialogic approach, and active student-centred learning), are presented. Sustaining equivalence in the quality of the online teaching and learning experience can be challenging when shifting from face-to-face to online contexts, particularly in the absence of explicit understanding and articulation of design practices.

This shift necessitates a systematic approach, such as Learning Design and the visualisation tool, which ensure that teachers have the tools and language to articulate and evaluate their design decisions and that the learning becomes activity-focused, rather than content-focused.

When Artificial Intelligence is introduced, the relationship between student outcomes and the online design will be better understood through mapping a) intended learning activities to learning design, and b) learning design to student outcome.

VI. FUTURE WORK

We are currently making an application for [Removed] Human Research Ethics approval to safely and securely analyse student demographics and behaviour and undertake data collection from teachers and developers engaging in the Learning Design methodology, as well as collect the artefacts of visualisation for analysis. At the same time, we will start manually coding the learning activities of each subject that will be entering [Removed]. This will feed into the AI algorithm that will be employed in Phase 1 of the project, to enable us to better understand the relationship between the design of an online subject and student outcomes.

Commented [A1]: insert this citation:

[1] Z. Yang, D. Yang, C. Dyer, X. He, A. Smola, and E. Hovy, "Hierarchical Attention Networks for Document Classification," in *Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*, 2016, pp. 1480–1489.

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