Individualised Categorical Teaching Based on Attentional Mechanisms in the Context of New Engineering Disciplines

Bingwu Ning[a] and Yunfei Tian[b*] and Xinli Zhu[c]

Changchun University of Architecture and Civil Engineering, Changchun, China

[a]ningbw256k@126.com, [b*]g93017207@gmail.com,
[c]ccjzzxl@163.com

Abstract. This paper proposes a new teaching method for artificial intelligence education in the context of new engineering, in response to the current education model, the number of students in each class is large and students comprehensive ability varies, and students' ability to accept knowledge is fast or slow. It is not easy for teachers to grasp the situation of students, which leads to the serious bifurcation of students ability, so this paper proposes a kind of student classification education based on the attention mechanism.

Keywords: Education, Personalisation, Classification, Attention.

1 Introduction

Li et al. proposed a personalised teaching[1], mentioning the problems in teaching engineering mathematics, such as the disconnection between theory and practice, the lack of personalised teaching and the insufficient opportunities for interaction and collaboration among students, and pointing out the potential and advantages of the application of artificial intelligence technologies in education. The paper emphasises the importance of personalised and collaborative learning in improving students' motivation and creative thinking skills, and discusses the changing role of teachers in the new teaching model.

Chen et al. summarised the previous experience of integrating information technology and communication internet into teaching and learning[2], and the paper referred to some previous studies such as Palvia et al. who pointed out the wide application of information and communication technology, the internet and information convergence technology in online education; and Villegas-Ch et al. who proposed a combination of data analytics techniques and AI technology to improve student learning; Chakraborty et al. compare the quality of teaching and learning in traditional classrooms and online education; Chen et al. compare the outcomes of online learning with traditional classroom accounting courses; Liu et al. study the impact of online continuing dental education during the COVID-19 epidemic; Danchikov et al. explore the potential of online learning under modern conditions and its application at different

I. A. Khan et al. (eds.), *Proceedings of the 2025 4th International Conference on Humanities, Wisdom Education and Service Management (HWESM 2025)*, Advances in Social Science, Education and Humanities Research 934,
https://doi.org/10.2991/978-2-38476-422-8_25

educational levels; Xu and Zhao investigated the synergistic relationship between online education and AI-driven electronic music creation and performance. These studies provide the theoretical foundation and research direction for this paper.

In their article, Li et al. explored the teaching reform and practice of AI courses in colleges and universities under the background of industry-teaching integration[3], analyzed the current teaching status of AI courses at the undergraduate level, summarized the teaching practices of colleges and universities at home and abroad, and proposed the direction of course reform and construction, such as improving the innovation and practical ability of students, focusing on the design of the course experimental case base, and optimizing the content of the courses such as the integration of the course ideology and politics, etc. For the main problems encountered in the process of offering AI courses, the future direction of the school's course construction was clarified, such as case-driven teaching, the establishment of the course Civics case database, online and offline hybrid teaching, and the diversification of assessment methods.

wang et al. proposed a teaching behaviour simulation method based on metacellular automata[4], and the article reviewed the applications of AI technology in the field of education, including assisted learning robots, teaching management supervision, curriculum design, teaching reform programmes, language learning systems, teaching assessment frameworks, teaching quality audit systems, film and television quality teaching models, engineering education optimization, and educational innovation paths. These literatures demonstrate the wide application and far-reaching impact of AI technology in education, providing the theoretical basis and practical examples for the research in the paper.

Yang et al. mentioned the application of AI technology in art and design education[5], including the use of automated design tools, data-based idea generation, and the provision of personalised learning experiences. At the same time, the limitations of teaching methods in traditional art and design education were pointed out, and the transformation of the roles of teachers and students and the necessity of updating teaching content with the assistance of AI technology were emphasised.

Tian et al. Experts and scholars at home and abroad have carried out some explorations and researches on the teaching reform of the computer vision course, such as integrating course ideology into teaching, innovating teaching methods, improving experimental methods, and integrating the concept of ‘new engineering’ into practical training[6]. These reforms have improved the quality of teaching to a certain extent, but they do not constitute a complete system. As a new course that emphasises both theory and practice, computer vision has problems such as short course time and untimely updating of teaching content.

Lin article first defines intelligent manufacturing and its development trend, clarifies the key role of mechanical design courses in intelligent manufacturing, and aligns with professional skills and market demand[7]. It then analyses the current situation of mechanical design teaching in the context of smart manufacturing, including changes in technical requirements, student competence needs and industry standards. Based on these analyses, strategies for modernisation and modularisation of course content, innovation of teaching methods, optimisation of practical teaching sessions, and application of information technology and smart tools are proposed.

2 Method

In this paper, we address the situation of too many classes and different levels of students in the existing education system, divide students' abilities based on the mechanism of attention, and then use the teaching model of assigning tasks in groups.

2.1 Introduction to the Attention Mechanism

The attention mechanism computes the output of the attention aggregation as a weighted sum of values. Through the attention aggregation of Query and Key, given a Query, calculate the correlation between Query and Key, and then multiply with the corresponding Value according to the correlation between Query and Key, to achieve the allocation of attention weights to Value, and generate the final output.

Taking a class of 76 students as an example, the attention mechanism calculation diagram is shown in Figure 1 below.

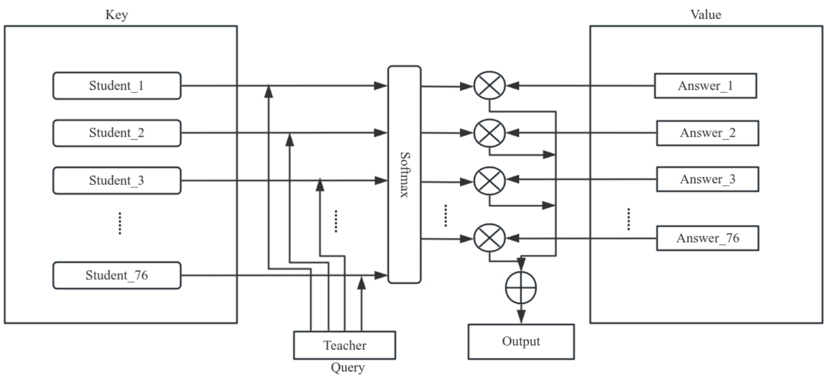

Fig. 1. Sketch of Attention Mechanisms Applied to Educating Students

In the diagram Key is the student's answer to the question posed by the teacher, Query is the question posed by the teacher, and V is the student's answer.

The correlation between Query and Key is calculated first, and then the attention scores are obtained by the softmax function, which is used to make all the attention scores between [0,1] and sum to 1. The correlation formula for Query and Key is generally expressed as follows:

$$score(q,k_i) = soft\max(\alpha(q,k_i)) = \frac{\exp(\alpha(q,k_i))}{\sum_1^j \exp(\alpha(q,k_j))}$$

We get the correlation of Query, Key, if the correlation is greater, the attention score is higher, and vice versa, the lower; and then multiply the attention score by the corresponding Value, and then perform a weighted summation; just for example: if the correlation between the teacher's question and the student's answer is larger, the higher the attention score will be; this allows the downstream task to understand that the question and the answer are a high degree of matching. This allows the downstream task to understand that the question and answer are a good match. Students with similar attention scores are then categorised to facilitate later teaching.

2.2 Implementation of Methods

The basic idea behind the introduction of the attention mechanism is that when dealing with sequential data of student responses, each element can be associated with other elements in the sequence, rather than just being dependent on elements in neighbouring positions. It adaptively captures long-range dependencies between elements by calculating their relative importance.

Specifically, for each element in the sequence, the self-attention mechanism computes the similarity between it and other elements, intends and normalises these similarities into attention weights. The output of the self-attention mechanism can then be obtained by weighting and summing each element with the corresponding attention weights. We hot-alone coded each word of the student's show in Figure 2 below.

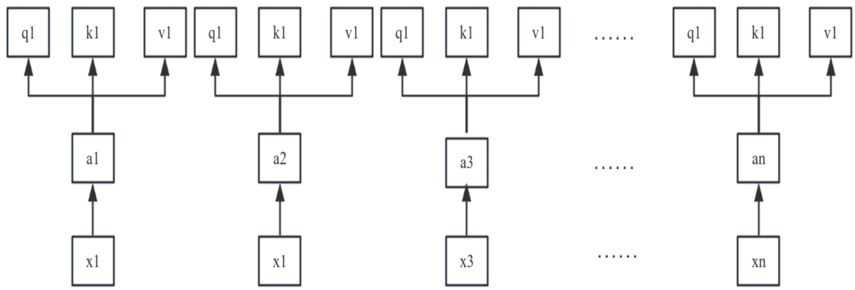

Fig. 2. Embedding operations on text

The formula is as follows, w is the weight matrix

$$a^i = wx^i$$

Considering the large number of Chinese characters, the correlation between the answers given by students to different questions may be too small, resulting in too much computation. The response time is too long, so the 76 students' answers are encoded with hot solo coding, as shown in Figure 3 below

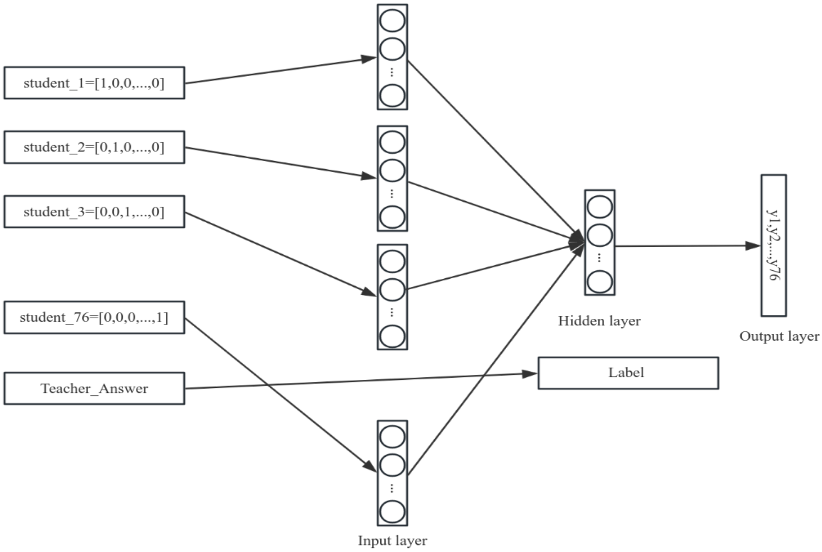

Fig. 3. The training process of word2vec

2.3 Training Process

Then the one-hot representation results [1,0,...,0],[0,1,...,0],[0,0,...,1], respectively, are multiplied by: a 77 × 76 input layer to hidden layer weight matrix W This matrix is also called the embedding matrix, which can be generated by random initialisation, and the random weight matrix is as follows.

$$w = \begin{bmatrix} w_{1,1} & w_{1,2} & \cdots & w_{1,76} \\ w_{2,1} & w_{2,2} & \cdots & w_{2,76} \\ w_{3,1} & w_{3,2} & \cdots & w_{3,76} \\ \cdots & \cdots & \cdots & \cdots \\ w_{77,1} & w_{77,2} & \cdots & w_{77,76} \end{bmatrix}$$

For example, take any student's answer and calculate:

$$\begin{bmatrix} w_{1,1} & w_{1,2} & \cdots & w_{1,76} \\ w_{2,1} & w_{2,2} & \cdots & w_{2,76} \\ w_{3,1} & w_{3,2} & \cdots & w_{3,76} \\ \cdots & \cdots & \cdots & \cdots \\ w_{77,1} & w_{77,2} & \cdots & w_{77,76} \end{bmatrix} \begin{bmatrix} 0 \\ 1 \\ 0 \\ \cdots \\ 0 \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ \cdots \\ x_{77} \end{bmatrix}$$

The obtained resultant vectors are averaged as hidden layer vectors:

$$\frac{V_1+V_1+V_1+\ldots+V_{76}}{76}=\begin{bmatrix} x_1^{'} \\ x_2^{'} \\ x_3^{'} \\ \ldots \\ x_{76}^{'} \end{bmatrix}$$

Similarly here after the W weight matrix of the output layer to get the information of the output matrix finally after the activation function to get the probability information and the labels to do the comparison, for the next step of training, and then apply the model to classify the degree of knowledge mastery of the students.

3 Conclusions

This paper takes a class of 76 students as an example, in the case of a professional teacher's energy can not pay attention to all the students, classification of students, according to the similarity of the attention mechanism scores of the students can be divided into 10 categories, the 10 understanding of the ability to understand the knowledge and mastery of the basics of the degree of proximity of the students as a 'system'.

References

1. Chen, K. (2023). Educational Reform Exploration of Engineering Mathematics from the Perspective of Artificial Intelligence. Adult and Higher Education, 5(18), 101-110.10.1007978-981-16-6502-8.
2. Zhang, B., Zhang, J., Zhang, C., & Sun, Y. (2021). Curriculum Reform and Exploration Under the Background of Artificial Intelligence and New Engineering. Artificial Intelligence in Education and Teaching Assessment, 251-259.10.1007/978-981-16-6502-8_22.
3. Shixin, L., Zhenyue, X., Yimeng, L., & Yun, L. (2023). Teaching Reform and Practice of Artificial Intelligence Course under the Background of Integration of Production and Teaching. International Journal of New Developments in Education, 5(22).10.25236/ijnde.2023.052230.
4. Wang, Z. (2023). Research on the Path of Teaching Reform of Colleges and Universities Courses in the Age of Artificial Intelligence. Applied Mathematics and Nonlinear Sciences, 9(1).10.2478/amns-2024-0910.
5. Zhao, Y., & Xue, Y. (2023). Research on the Teaching Reform of Art and Design Courses in Colleges and Universities Driven by Artificial Intelligence. Applied Mathematics and Nonlinear Sciences, 9(1).10.2478/amns-2024-0625.
6. Cun, T., & Sha, Z. (2023, June). Teaching Reform of Computer Vision Course in the Context of Artificial Intelligence. In 2023 4th International Conference on Education, Knowledge and Information Management (ICEKIM 2023) (pp. 782-795). Atlantis Press.
7. Lin, X. (2024). Teaching Reform and Exploration of Mechanical Design Courses in the Context of Intelligent Manufacturing. Journal of Computer Technology and Electronic Research, 1(2).10.70767/jcter.v1i2.216.