

Driving Momentum to Higher Order Learning with AI Through the PONDU Model

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Abstract: Education has seen significant transformation in its role, funding, and approach to learning. This required reassessment of what is the best way for pupils and students to learn. This article highlights the exponential trend of AI in education involving AI applications, resulting in supporting evolving knowledge and skill requirements in the labour market. Thus reskilling the UK workforce for a more technologically adapt future. A new educational model, the PONDU Model, is designed for this purpose. Pre - class activity using AI applications, allowing for testing of knowledge and understanding. Personal and collaborative learning ensuring student understanding and engagement. In class use of flipped learning pedagogy resulting in student motivation, participation and path to higher order learning. Post class activity allowing for evaluation and achievement of higher order learning, using AI driven assessments. The PONDU Model is formulated by a structured approach within which student learning is developed. At the asynchronous stage, the use of an avatar or virtual assistant and peer review in testing knowledge, understanding and reflection is applied. In addition, through the use of learning analytics, students' learning characteristics can be identified and supported using adapted AI applications to enhance personal learning. Continued through the synchronous stage, based on flipped learning with gamification options to the post synchronous stage where higher order learning is achieved, supported by AI applications. The research leading to the PONDU Model design is based on a qualitative research strategy, using secondary research data, collected and analysed from secondary academic sources. Student feedback acquired through a module feedback mechanism, indicating student satisfaction and higher order learning using flipped learning, is also used. The conclusions indicate that at the asynchronous stage in the PONDU Model there is scope for multiple digital and AI applications; further scope for AI and gamification in the synchronous teaching and learning stage and summative asynchronous stage involving summative assessment, with the result of higher order student learning. The PONDU Model approach is recognising the value added by digital and AI applications.

Keywords: Flipped learning, Artificial intelligence, Constructivist learning, Gamification, Pedagogic model – the PONDU model

1. Introduction

The world of employment being more integrated and rapidly changing, those services such as education are therefore needing to ensure they are providing provision that can meet these, if not future, requirements. According to Dixon and Gordon (2022)'s research, it is key that graduate employers want to hire well rounded and experienced, recognised as general workplace experience, individuals.(Dixon and Gordon 2022). The challenge for Higher Education Institutions is to design the learning materials to reflect current real-life experiences and how students will perceive these approaches. (Oliver and Jorre de St Jorre, 2018). Universities will be needing to highlight timeless attributes, such as professional and personal digital safety; learning and working collaboratively including across time zones and using digital channels. Also resilience and mental wellbeing; the ability to judge the veracity of information (critical thinking); and global citizenship that includes understanding history, politics and international relations (Collins 2019). These attributes are likely to be essential in the new and rapidly evolving world of work – regardless of unforeseen events (Collins 2019). This includes Artificial Intelligence (AI), with Tabioulas, and Shadbolt, (2023) indicating that "AI can empower us rather than diminish us, if we are all part of a conversation about the values we wish to imbue in our systems and the regulatory environment in which they exist" (Tabioulas & Shadbolt, 2023). It is therefore becoming incumbent on university academics to prepare today's students for jobs that are in existence, those that might change in the future and jobs that do not yet exist.

The role and practical application of AI also extends to education. How can AI and its experience interconnect and what is its value to the learning process of its recipients? It is thus beneficial to further research into current applications AI can have in education and AI's contribution to achieving higher order learning of the recipients.

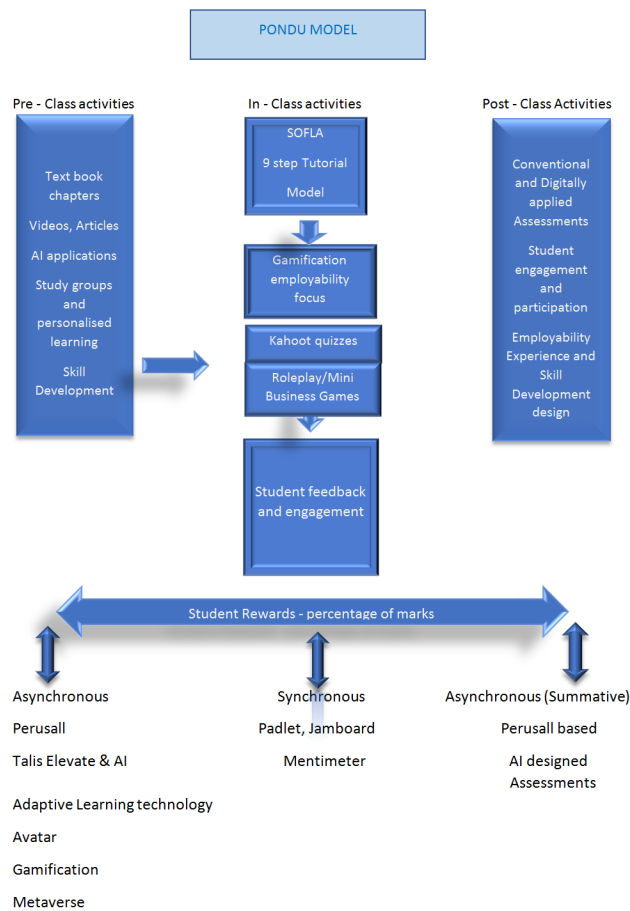
Various applications of AI in education (referred to as AIED) are accentuated by Timms (2016) namely: as a pedagogical tool, or an instructional platform or simulation-based instructions. This includes using different technologies, such as virtual reality to demonstrate or show students concepts or practically demonstrate materials. This gives students an experiential or practical learning experience. (Timms 2016). Current

applications of AI in the form of AI - powered tools, such as chatbots, robots and virtual assistants are increasingly available, offering immediate guidance and support to students, irrespective of their location or time zones.

Learning analytics, accentuated by Yi-Shan and Gasevic, (2017), focuses on data from the students' characteristics and knowledge objects from learner model and knowledge field model (Yi-Shan and Gasevic 2017). The purpose is to tailor educational method to the individual learner's need and ability. For example intervening with students at risk or providing feedback and instructional content. A clear indication how AI can be effectively used in education, expressing itself in the ability to also focus on the individual learners needs, in addition to the contribution to overall education.

2. What is the PONDU Model

PONDU Model - Description of the Model



(Source: Author 2022)

Figure 1: PONDU Model 2024

The above model is the newly designed Pedagogic Model, which forms the central context of this article. The underlying pedagogic principles are of flipped learning and its structural divide of formative asynchronous, synchronous and summative asynchronous learning opportunities. The Model further accentuates the principles of student focused and collaborative-based learning within the formative asynchronous and synchronous learning structure. The role of AI technology and its associated AI enabled learning systems within this structure is the theme of this article and how AI can be effectively used in support of the student's learning experience.

The synchronous stage is contextualised through the use and structure of the Synchronised Off-Line Flipped Learning Approach (SOFLA) Model and in particular the third, fourth and fifth stage involving gamification, team working in breakout groups and the collective feedback sessions of the student learning, involving Jam board or Padlet applications.

Table 1: SOFLA Model

<p>Step1 - Pre-work Pre-work occurs asynchronously. Students view a short video with embedded interactions. Complete related readings and/or activities.</p>
<p>Step 2 – Sign-In Activity The virtual or in class activities begins with an open-ended prompt related to the lesson topic. The students write their responses to the prompt in a shared space and sign in.</p>
<p>Step 3 – Whole- Group Application The entire class collaborates on an activity to clarify misconceptions and/or deepen their learning of the topic in a shared space.</p>
<p>Step 4 – Breakout Teacher provides explicit instructions for a structured group activity and directs students to breakout rooms to apply what they have learned. Each group is accountable for the product that documents their work.</p>
<p>Step 5 - Share-Out Groups return from breakouts and share their work by presenting their product Information or findings. Other students offer feedback using the SHAC (Share, Help, Ask, Comment) Protocol.</p>
<p>Step – 6 - Preview and Discovery The teacher shows the student selected content from the next pre-work, introduces key terms and concepts, and asks questions to engage them in the new material.</p>
<p>Step – 7 – Assignment Instructions The teacher explains each assigned task for the next pre-work viewing assignment, indicating the timeframe and the location of resources. Teacher responds to student requests for clarification.</p>
<p>Step – 8 – Reflection The synchronous virtual/in class session ends with an opened-ended prompt. In a shared space, students write something that resonated with them from the lesson and sign their name.</p>

(Source: SOFLA model (Marshall & Kostka, 2020)

3. How Does AI in Education (AIED) Connect with the PONDU Model

The application of AI, in the design of the formative asynchronous and synchronous stages of the PONDU Model refers to the AIED Bloom’s Taxonomy (2024) as a framework and its levels indicated below and the view held by Simões, Redondo and Vilas (2013), stipulating:

- Multiple performances – the learning activities to be designed so that students can repeat them in case of an unsuccessful attempt. As a result of repetitions students will improve their skills and achieve their goals.
- Feasibility – the learning activities should be achievable. They have to be tailored and adapted to students' potential and skill levels.
- Increasing difficulty level – each subsequent task is expected to be more complex, requiring more efforts from students and corresponding to their newly acquired knowledge and skills.
- Multiple paths – in order to develop diverse skills in learners, they need to be able to reach the objectives by various paths. This allows students to build their own strategies, which is one of the key characteristics of active learning and emphasising the design's outcomes of needing to be engaging, interactive and rich use made of elements of multimedia, with the training activities focused to achieve the learning objectives.(Simões, Redondo and Vilas (2013).

These learning characteristics are further developed in the Model through its principal stages.

4. Formative Asynchronous Stage

From research the indication is that the asynchronous stage of pre-class activities is the most vulnerable in terms of student engagement in completing the required reading and tasks in preparation of the synchronous stage.

Reiterating the pedagogic approach of Flipped learning, Bishop, and Verleger (2013) articulate that "Flipped Learning differs from the earlier blended learning model in that it consists of two types of learning: individual learning as homework outside the classroom and interactive group-based learning inside the classroom" (Bishop and Verleger 2013).

The pre-class formative asynchronous stage is the individual learning stage, accentuated as homework outside the classroom and thus, based on the characteristics above, is dealing with the multiple performances and paths, in the preparation of students for their in-class interactive learning.

Taking a closer look at the pedagogic approach and above-mentioned characteristics, what does this stage involve and significantly how can AI contribute to the activities and learning at this asynchronous stage. The approach within the formative asynchronous phase will be divided into the two broad parts, namely student-centred learning and team-based learning.

4.1 Student- Centred Learning

This approach, based on the individual, seeks 'mastery learning' and subsequent requirements for differentiation of learning, be this due to the different level of knowledge to individual learning styles, resulting in 'personalisation' of instruction. This section firstly deals with learning opportunities, which are supplemented by the AI systems which have been proposed and designed as an answer.

A foundation stone to personalisation and 'mastery of learning' is the ability to assess and adjust learning experiences, achieved through the use of algorithmic adaptivity to achieve higher order learning.

4.1.1 Algorithmic adaptivity

Algorithmic adaptivity refers to the process of using algorithms to dynamically adjust learning experiences based on individual needs. It involves answering two key questions:

- What does the learner understand or 'know'?
- What should the learner encounter next in their learning journey?

By analysing these answers, algorithms can identify and deliver the most suitable learning item at the optimal moment, tailoring the experience to each student and enhancing the personal learning experience. Two widely used approaches in algorithmic adaptivity are:

- Bayesian Knowledge Tracing (BKT): This algorithm estimates learning rates and tracks the progression of knowledge acquisition.
- Item Response Theory (IRT): Originating from psychometrics, this framework models how learners interact with specific items, providing insights into their capabilities.

These adaptive processes rely on multiple adaptivity factors, including performance metrics (current and past activities), knowledge levels (prior or newly acquired), content preferences, misconceptions, demographic data, and other relevant sources. These adaptivity factors are used to determine adaptive responses, which could

range from following the planned learning path, providing targeted hints, or entirely rerouting the learner's journey based on their progress and needs. By strategically employing these responses, educators and technologists can craft engaging and effective adaptive learning environments and materials, incorporating AI applications.

As outlined in the Model, the teaching materials are of a conventional nature, consisting of the recommended textbook, articles, lecture slides and video materials designed for the purpose of achieving required Learning Objectives. Applying these teaching materials is, however, being put in the context of the AI application and thus a very different approach of their use and approach.

The use of the Avatar and Chatbot as Virtual Role players and/or Teaching companions has a significant role in the application of achieving the 'mastery' of the learning. Achieved with AI, through the use of FeedbackFruits, Peerceptiv, Perusall or Talis Elevate. Conversational AI can be as impressive as the business creates it, and its essence is to "learn" from each user's communication. Such chatbots make use of some of the principles of natural language. (NLG) and using this technique, the chatbot can search data in repositories, including third-party databases, and use that information to create a human-sounding response. Providing a conversational experience and offer more precise information. The 2024 released GPT 4.0 AI-based avatars will be able to process a combination of images, videos, and audio sequences, and respond using these various media (Open AI 2024). Through the use of the mentioned techniques conversational AI allows for much more sophisticated dialogue systems to be created.

The textbook as a minimum is available as an e-book, and it is the following stages where AI transform the reading into learning mastery. These latter AI tools, as interactive group engaging AI applications, are applied to the learning taking place from the textbook or other learning materials. Comments are required to be made on the chapter to be read or the defined learning materials in preparation for the in-class activities, which are subsequently commented upon by the student's peer group.

The second approach taken for developing 'mastery of learning' in personalised and student-centred learning, is through using an Avatar as a tutoring system, to whom the student can pose questions to check their understanding and getting the right answers. Individualised teaching of materials is made available, emulating the style of programmed learning of review of materials and allowing several attempts to achieve the correct answers. An example of this is GPTAvatar, used in Convai, a "dynamic avatar application which records user input via microphone, converts words to text using automatic speech recognition, resulting in being able to, through synthetic human voice, interact engage and make adaptive adjustments where required, based on student progress" (Marczewski 2013).

4.1.2 Gamification

Augmenting this stage further is by gamification. The use of game mechanics, according to Zickermann (2013), improves the abilities to learn new skills by 40%. Game approaches lead to higher level of commitment and motivation of users to activities and processes in which they are involved, resulting in active learning (Zickermann 2013). Game Based Learning normally uses challenges, mysteries, competitions, and rewards and have features of quests, points, feedback and badges which are perceived as being motivating and constructive learning environments (Westwood and Barker 1990). This applies to other diverse types of games which may include puzzle game, role-playing games, simulations, and strategy game, played using different digital technologies, such as mobile phones, online games, virtual worlds and Alternative Reality Games (ARG) (Connolly, Boyle, MacArthur, Hailey, and Boyle 2012).

Research by Leaning, (2015) based on media studies students, indicated that there are positive attributes in the form of students having changed their psychological approach to study as a consequence of the gamified activities on the module. (Leaning 2015).

4.2 Collaborative Based Learning

Group learning is achieved through the formation of ethnically and academically diversified study groups and pre-class 'tutorial' groups. Enhancing inclusivity and diversity, the communal discussions are achieved through group construction based on the diversity of the students backgrounds. (Different nationalities and geographical mix. Schooling, Mix of subject discipline, underrepresented groups, disability such as with learning agreements). Zou, et al (2018) indicated that a greater amount of interaction with host nationals has been associated with fewer academic problems, fewer social difficulties, improved communication competency, and better general adaptation to life overseas (Zhou, X., Zhang, X., Lin, M. and Sun 2018). Feedback Fruits AI tool allows instructors

to make effective, well balanced and inclusive groups to enhance group dynamics, learning outcomes, student satisfaction and engagement. In the words of Hsin-Yuan Huang, and Soman, (2013) activities that require independent work by students bring individual awards (such as badges). Activities requiring interaction with other learners are the social element of training; they make students a part of a big learning community and their results are public and visible (such as leaderboards) (Hsin-Yuan Huang, Soman 2013).

The collaborative approach or team-based learning is designed through the use of Talis Elevate, amplified using Perusall or FeedbackFruits, using a journal article, video, newspaper and report reviews, a practical case study related to the book chapter and lecture slides for use in the synchronous session. These are made available pre-class, by using these collaborative AI tools. The management of these collaborative approaches is in part based on monitoring of activities and engagement via the analytics available on the Virtual Learning System, (VLS) indicating pre-class engagement with materials.

4.2.1 Talis Elevate

Talis Elevate is an AI tool to focus on collaborative learning in reading and annotation for community-based learning and sharing ideas in both onsite and online learning environments. Achieved through the academics uploading to the platform, from a variety of resources, customised teaching packs. These packs can consist of bespoke made videos, YouTube videos, research and/or subject specific journal articles and textbook chapters. Students collaboratively then engage with these learning materials and through analytics, teaching staff can see who's using the material.

The analytics reveals insights on student behaviours, allowing tutors to fine tune their input in Stage 3 of the synchronous stage of the PONDU Model, based on these analytics insights. (Talis Elevate 2023)

Creates communities in the teaching content

With Talis Elevate providing the technical platform, it is recognising students can learn a lot from each other for them to co-create knowledge together within the subject matter. Building communal discussion directly into course content.

Collaborative reading & commenting helps students feel more connected to their peers and more confident sharing their views. Talis Elevate brings the students' discussion into the tutors content. They create knowledge together, help each other out, and pose questions within the subject matter. (Barrett, East, Fitzgibbons, Vescovi, Wood 2023).

Develops more engaged students

Talis Elevate gives direct help to those students in need through the analytics provided, which are focused on active student participation, allowing to see who's not engaging with online learning tasks each week. This allows for the academics to target help toward those that need it most and further stimulate engagement. Insight into this application and impact of Talis Elevate, is highlighted by research done at Lincoln University. (Barrett, East, Fitzgibbons, Vescovi, Wood 2023).

In general, the tool was deployed to support asynchronous learning, although there was also some 'live' usage with students annotating sources during synchronous online classes. An indication of how it was used is for example asking students to engage with videos, identify points of interest in preparatory reading and sharing thoughts about readings with peers.

"Talis Elevate was used by staff and students in a variety of ways to promote active engagement with texts and create opportunities for interaction amongst students and between staff and students"
(Adams and Wilson 2020).

The use of Perusall in conjunction with Talis Elevate can help to accentuate the initial personalised learning within the context of collaborative learning and the team approach. Thus, developing a sub model for formative asynchronous learning, based on Perusall and Talis Elevate to promote the social learning.

4.2.2 Perusall

Perusall is a complimentary collaborative AI tool, providing collaborative reading and annotation for both onsite and online learning environments for community-based learning and sharing ideas.

Perusall as a tool can develop collaborative reading, enabling coordinated and collective student reading of course materials. Thus stimulating students collectively in comprehending complex theoretical concepts and terminology in a team or group setting (Miller, Lukoff, King Mazur 2018).. Furthermore, Perusall gives the opportunity of formative marking, giving students the opportunity to improve their knowledge and understanding in preparation for the summative assessment.

Creates communities in the learning setting

Consequently, Perusall can support formative asynchronous learning through official or student-organized study groups, or as preparation for synchronous tutorials. Much research and as an example by Seow and Fong, (2018) on an online science reading assignment designed for authentic engagement outside class, indicated that the interactive format of anchored discussions combined with primary literature promoted genuine collaborative scientific learning. Notably, student interactions frequently went beyond the specific articles, evolving from questions about data ambiguities to an understanding of the subjectivity inherent in data interpretation. These findings suggest that exposure to primary literature coupled with student discussion deepens their grasp of scientific research and the nature of science. Perusall proved to be a valuable tool for facilitating this type of engaging out-of-class activity.

Creates engaged students

When students engage with primary literature and discuss it with their peers on the Perusall platform, their engagement and understanding are notably improved. This positions Perusall as a highly beneficial AI tool for extending student interaction and learning beyond the classroom. Instructors can assign various formative asynchronous reading materials in Perusall, such as textbook chapters, research articles, or even videos. The platform allows students to comment on these materials, and instructors can choose to mark these contributions.

What sets Perusall apart is its emphasis on tailoring learning to the individual within a collaborative space. Additionally, the platform provides reports that can identify challenging content, allowing instructors to address these specific points during later synchronous meetings.

Perusall acts as a valuable and complementary AI tool to FeedbackFruits, its contribution discussed below:

4.2.3 *FeedbackFruits*

Focussing on the collaborative dimension of the formative asynchronous stage of the PONDU Model, Feedbackfruits is a comprehensive collaborative and annotation platform.

Creates engaged and collaborative students

FeedbackFruits aims to promote student engagement through peer review on tutor designed assignments against set criteria. Although equally peer review of collaborative contributions, through student evaluation of peers' contribution to group work and how effective the evaluation is, the review is based on tutor specified criteria. This latter element is of particular interest to assessing the effectiveness of study groups created in the formative asynchronous stage.

4.2.4 *Peerceptiv*

Peerceptive, emphasises the collaborative aspect of the Model allowing for peer review on assessments, enabling students to provide and receive feedback on various assignment types (writing, presentations, videos, etc.) using instructor-defined rubrics.

In addition Peerceptiv allows students to evaluate team members contributions and collaboration skills in study groups and forms of group projects. The latter being for example presentations, where real-time peer feedback and evaluation can be given.

Furthermore, in a collaborative context, through feedback on the reviews received, students can make judgements about the helpfulness and quality of the peer reviews given.

5. Synchronous Stage

The synchronous, or in-class, stage of the model is structured using the SOFLA Model framework, as previously described. Steps 3 to 5, which focus on active learning, are enriched through the application of gamification, fostering an environment conducive to higher-order learning.

- *Step 3:* Active engagement begins with competitive Kahoot quizzes, videos, or, where applicable, short role-play exercises and mini business games. These activities aim to stimulate students' interest and participation.
- *Step 4:* This step involves a variety of activities designed to deepen understanding and apply concepts learned during the formative asynchronous stage. These may include business simulations, strategy games, discussions around articles, case studies, or further analysis of the video from Step 3. Practical, team-based learning is enhanced through gamification, promoting both collaborative and individual learning. Team leaders can be appointed to facilitate discussions and activities, thereby fostering employability skills such as leadership and teamwork.
- *Step 5:* Feedback is provided through interactive tools that encourage collaboration and reflection. Padlet offers a platform for students to record and organize key ideas. Mentimeter facilitates real-time visualization of their thoughts and responses. Jamboard adds an interactive dimension, allowing students and tutors to share and refine feedback dynamically. To further enhance motivation, awards are given to the top three performing groups, with their achievements prominently displayed on a leaderboard. This public recognition serves to foster healthy competition and celebrate student success within the module.

6. Summative Asynchronous Stage

The final, summative asynchronous stage of the PONDU Model focuses on evaluating student learning and the achievement of higher-order skills. AI offers valuable tools not only for assessing these skills but also for supporting their development. Several AI applications are relevant to the development and assessment within this stage. Examples include GPT-4, Peerceptiv, able to create flexible grading and customise rubrics and the recently developed Teacher GAIA, which can assist in both the creation and practice of summative assessment tasks.

However, research by Klyshbekova and Abbott (2024) indicates that ChatGPT-4 has limitations concerning referencing, writing length, creativity, and originality. (Klyshbekova and Abbott (2024)). Despite these constraints, it demonstrates capabilities in more routine tasks such as finding materials and developing arguments. Therefore, the primary role of ChatGPT-4 in the summative asynchronous stage may be to enhance efficiency for academics in constructing the linguistic aspects of summative assessments, rather than in the marking process itself.

FeedbackFruits provides AI support for tutors in facilitating feedback on summative assessments, including presentations and oral exams. It also offers AI-driven assistance to improve student learning through in-line feedback on summative assignments.

Practical applications of the use of AI in summative assessments, include the development of benefit-risk assessment models. The creation of videos and films as summative outputs, utilizing tools like Adobe in fields such as creative arts, business, and medicine. Perusal, streamlining peer review by combining automated feedback grading with peer assessment, saving instructors time in setup and review. FeedbackFruits offering similar capabilities, allowing instructors to design assignments where students provide feedback on peers' work (documents or videos) based on predefined criteria.

7. Example of a Practical Implementation

Implementing the asynchronous stage starts with the formation of study groups, their size dependent upon the overall cohort. To accommodate personal learning, the Virtual Teaching Assistant through conversational AI is created using GPTAvatar in Convai. The next step is to construct the content of the teaching materials, aligned with the learning outcomes with the final stage of selecting the AI tools to facilitate collaborative learning and incorporate them into the Canvas or Moodle site.

8. Conclusion

The PONDU Model, through its structured design and systematic approach achieves higher order learning. The three stages, acting as building blocks to each other and based on a proven engaging pedagogy of flipped learning, the Model stimulates both personal and collaborative learning.

Using the AI and gamification applications, involving individual and collaborative feedback and discussion, leading to mastery of subject learning.

Using various AI tools in the pre-class stage leads to better understanding of the teaching materials, learning enhanced through the activities in the steps in the Sofla Model and further put into practice in the nature of the AI supported assessments.

Contributing to future research, assessment of multidisciplinary effectiveness in each stage in AI applications and student achievements is conducted. Furthermore, through a longitudinal study able to develop a trend of student achievements and results.

Abbreviations

AI - Artificial intelligence

AIED - AI in Education

ALS - Adaptive Learning Systems

ARG - Alternative Reality Game

BKT - Bayesian Knowledge Tracing

GBL - Game - based Learning

IRT - Item Response Theory

NLG - Natural Language Generation

SOFLA-Synchronised Off-Line Flipped Learning Approach

VLS - Virtual Learning Systems

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