NO ONE LEFT BEHIND: THE FIRST "AIDAGOGY" STRATEGY FOR PIE (PARTNERSHIP IN EDUCATION) COMMUNITY DEVELOPMENT

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ABSTRACT

There are digital divides for pupils in Southeast Asia, especially in the aspect of AI for assessment and feedback. From digital tools to AI, the related research communities remain solo for delivering educational robots with machine learning capabilities from STEM (Science, Technology, Engineering & Maths) discipline. Huge work has been committed for Educational Technology (EdTech) researchers for a crossed disciplinary effort (STEM with educational theory), including British Council funded PIE for women programme, aiming to bridge the gap and to promote equality. A series of educational robotics projects, e.g. AIdagogy in AF (Assessment & Feedback), acts as academic-led outreach strategy between two universities from UK and Malaysia, for inclusive schools' trials across the two nations: the UK technology origins from EUREKA Robotics Centre with Robot EUREKA, JD Robots and Robot Xiaolongbao for in-class personalised coding learning with assessment and feedback, coupled with the Malaysia home-built STEM robots by the STEM Lab from University Malaysia Pahang Al-Sultan Abdullah. Action research methods with rapid prototype development were adapted for the work for selected underprivileged communities including Muslim & Christian, and Malaysian & British pupils, in particularly girls. Pilot experiments were conducted in Wales, England and Malaysia for user acceptance with effective results from both students and teachers, as part of a larger scale rolled out between 2022-2029 for the Global PIE for Women programme, this work is a pilot for community learning to other partnering universities in Malaysia, Indonesia, Pakistan and Wales: our work-in-progress and future work are reflected reviewed and enhanced with recommendations for other to reference from.

Keywords: assessment & feedback, ai in education, educational robot, neural image captioning

INTRODUCTION

Assessment feedback is constitutive to the effectiveness and efficiency of learning and teaching (Gibbs and Simpson, 2004). Since the dissatisfaction of UK students, in general, for assessment feedback was being revealed (NUS 2009) in the early days of assessment & feedback educational research, considerable efforts have been put forward for the awareness raising and showcase of change practices across the UK on related agenda (HEA Assessment and Feedback, 2011; A&E Seminar Series, 2011-2024). Students find that educators 'did not care enough to spend time on the feedback particularly where tick box feedback sheets had been used which students regarded as an "insult" ' (Price, Handley, Millar & O'Donovan, 2010, p.282). In order to address the issues previously noted, EdTech or educational robots for assessment are becoming increasingly 'fashionable' in the last decade (Anwar et al., 2019; Atman Uslu et al., 2022). On the other hand, the practice of technology including AI and robots in assessment and feedback to substitute traditional grading and feedback process are still not pervasive across disciplines in the 21st centuries, and the impact of such innovative assessment adoption is still emerging (JISC, 2010). Limited investigation has been researched on the pedagogical capabilities and trust of technology and AI in assessment and feedback for learning with international influences (Mora, Sancho-Bru, Iserte & Sánche, 2012; Yang et al. 2024). We grounded on Price et al. (2010) to note that students often alienated from submitted assignment which they perceive as a 'finished product'. Rather than part of a conversational learning process, they are unlikely to concern the assessment feedback that review to the 'finished product' – what does it matter? Unless the practitioners' perception shift from a finished product of university's assignment to a dialogic communication and learning experience through feedback, where technology with AI (Artificial Intelligence) capabilities in assessment and feedback can be instrumental.

REVIEW FOR THE EVOLUTION OF TECHNOLOGY BECOME PEDAGOGY

Technology Become Pedagogy in Assessment and Feedback

A traditional investigation is the comparative evaluation of technology in assessment and feedback to traditional and manual process (Rovai, 2000; Venable et al., 2012). Finding of massive quantitative research conducted by the U.S.

Department of Education suggests that the positive effects associated with technology enhanced learning, teaching and assessment should not be attributed to the technology (Means, Toyama, Murphy, Bakia & Jones, 2010). Some researchers perceive the role of technology is merely a vehicle that delivers instruction and assessment, and has no significant effects on learning (Russel, 1999; Perraton, 2000). O'Toole and Absalom (2003) researched the impact of educational technology on learning outcomes. They concluded that technology is unlikely to be effective if it is merely a replacement for traditional settings such as lectures or is seen as an alternative mode of delivery. Pachler, Daly, Mor, & Mellar (2010) further indicate that technology in assessment and feedback for formative learning must involve both 'technological and social resources by which individuals (learners and educators) are enabled to engage agentively with evidence of learning, in order to effect changes in understanding' (pp.720). They highlight the main key actors in such pedagogical engagement are the students and educators; technology, thus, can never secure such engagement but shape the possibility for this to happen. Innovatively, Laurillard (2002) provides a model for rethinking university teaching because of technology intrusion and close the polarisation to be blended or hybrid learning with technology. Vaughan and Garrison (2005) creatively argue that the thoughtful integration of traditional face-to-face classroom (spontaneous verbal discourse) and online (reflective text-based discourse) learning opportunities is not an alternate mode of learning and teaching delivery. It is the fundamental redesign and an optimal (re)design approach to enhance and extend learning by rethinking and restructuring teaching and learning.

Further investigation of how effective and disruptive that technology in assessment and feedback impose the above principles is necessary. There is a paradigm shift from educator-centered to student-centered in the last few decades. Students learn from constructive reasoning, self-reflection and are shaped to conform to necessity, not to the authoritative instructions or feedback from educators. Thus the development of students' self-assessment skills is of paramount vital in assessment and feedback research, both with conventional blended learning or AI - learning and teaching take place in a reflective process and shared investigation between educator and learners, with the emphasis of the dialogue between both parties during assessment and feedback (Glass, 2001; Kay, 2011; Chew, 2015; 2021). Interpretation and reasoning from feedback involves students actively constructing their own learning from the feedback and making their own sense of it (Kay, 2011). Hence, the popular view of last two decade of literatures is that assessment feedback must address feed-forward rather than feedback alone (Gibbs & Simpson 2004; Tetta, Hounsellb, Christiec, Creed & McCuneb, 2012). Regardless how hard educators were trying to provide clear and quality feedback, students still perceive that learning from feedback could only be developed via dialogic feedback – feed-forward (Price et al., 2010). Sadler (2010) asserts that assessment and feedback is a complex process that neither set of rules nor blanket approach which adequately facilitates such process. Taking a different view from Sadler and after the extensive review of 91 scholarly articles, Gikandi et al. (2011) suggest that technology in assessment for learning can possibly lead to pedagogical enhancement which provides 'a means to align assessment with learning and teaching, and inevitably change how learning and assessment occur (p.2345)'. **To paraphrase, such change is when technology become pedagogy is our focused work to present in this paper.** Acknowledging the complexness of assessment and feedback, hence, the question here is that when technology in assessment and feedback for learning becomes pedagogy in assessment and feedback (or when it is not) - what conditions and practices influence the effectiveness of technology in assessment and feedback? PIE (2022-2024) is a helpful venue to attempt this new idea.

AI enabled Robotics in Assessment and Feedback with Disruptive Intervention

Borrowing the above 2.1 insights to the context of AI enabled robotics in assessment and feedback, it is possible that these innovative technologies in assessment and feedback becomes pedagogy in assessment and feedback for learning with the following propositions: (1) AI enabled Robots in assessment and feedback will merely enable learning if it mainly focuses on addressing operational issues such as accessibility and flexibility of the coursework submission, assessment and feedback through a different modality; (2) AI enabled Robots in assessment and feedback will enhance learning if it allows incremental changes to the pedagogy but do not radically change the assessment and feedback practice; (3) AI enabled Robots in assessment and feedback will transform learning and assessment experience if it allows a radical transformation of the pedagogy in the thoughtful integration process of technology by revisiting, rethinking and redesign assessment and feedback. While Anwar et al. (2019) systematically review the work of educational robotics, we stress that effective feedback is the most critical facet within assessment processes. Our sustainable PIE Programme (PIE, 2022-2024) would propose the thoughtful integration of AI-Robot, adapting Knight and Ferell (2022)'s and Gikandi, et al. (2011)'s Seven Principles (**SP**) of what valuable feedback are:

- SP1: helps clarify what good performance and assessment criteria is;
- SP2: facilitates the development of personalised reflection, self-generated feedback, self-regulation and self-assessment in learning by being accessible, inclusive and compassionate;
- SP3: delivers high quality feedback for formative development that helps autonomous learners' self-correct;
- SP4: encourages interaction and dialogue around learning (teacher-peer-student);

- SP5: encourages positive motivational beliefs and self-esteem with managing educators and learner workload effectively by having the right assessment, at the right time, supported by efficient educational processes;
- SP6: provides opportunities to close the gap between current and desired and sustainable performance: foster a motivated learning community by involving students in decision-making and supporting staff to critique and develop their own practice
- SP7: provides information to teachers that can be used to help shape their teaching with employability and promoting ethical conduct.

AI and Robots in assessment and feedback is likely to be ineffective if it is merely a replacement for the same traditional assessment process and practice. It is insignificant to 'recycle' the same practice from offline to online, or from manual computerised processes to AI-Robots, as same poor pedagogical practices remain unchanged. Instead, technology should inspire educators to revisit and potentially change their approach to assessment and feedback for dialogic learning in ways that are positive for the student. This proposal aligned with the Vygotsky's Zone of Proximal development to integrate educational robots as peer assistant (Walker, 2010) and for learning companionship (Yang et al., 2021). Chew et al. (2015; 2016; 2020; 2021) fundamentally and thoughtfully integrate educational robots into the redesign of learning, assessment and feedback. Yang et al. (2021) also propose the companionship theory for integrating humanoid robots into education and healthcare for personalised services. This paper further the work to a pilot-scale of PIE experiment in two nations: the UK and Malaysia, aiming to propose **AIdagogy** strategy among the PIE community.

METHOD

The inquiry started with British Council Catalyst grant for crossed-countries Partnership for Education (PIE, 2022-2024). Through the British Council funded PIE community development, a cross-sectional Observational Study (Elsevier, 2022) in two-countries experiment is adapted to develop the proposed AIdagogy definition and AIdagogy in AF (Assessment & Feedback) model. This paper reports the initial progress and finding for two universities out of the eight PIE partnering organisations. Recruiting non-technical teachers and pupils in college, high schools, and primary schools, targeting female and B40 communities, we conducted and compare seven STEM workshops with the same humanoid educational robotics, aiming to increase their AI literacy (as shown in the below Table):

Table 1. STEM-Robotics Workshops with thoughtful integration of AIdagogy in AF between 2023-2024

	Glyncoed Primary School in Cardiff, Wales	***MaryMount International Girls' School, London, UK***	***Robot Weena at Eisteddfod, Wales***	***Cardiff Chinese Christian Church, Wales***	***Methodist church, Kuantan, Malaysia***	***Department of State Education, Pahang JPNP***	***TVET Malaysia Kuantan Vocational Colleges***
Teachers	2	2	2	2	3	30	6
Pupils	42	43	95	63	30	30	70
Tech-Robot Used	Nao Robot, RoboMaster and EUREKA Leg (https://x.com/glyncoedprm1/status/1811749174263841055) (Robot Literacy)	RoboMaster and EZB Robot (https://x.com/eurekarobot/status/1629167113830076417)	NAO Robot (https://x.com/RowenaA/status/1820753237835645 09)	Python & Robot Mini (Robot Literacy)	Eureka Robot & UMP STEM Bot (Noordin et al., 2022) (Robot Literacy)	Arduino Robotics (Noordin, 2022) & Python Programming (Noordin, 2024)	Eureka Robot & UMP STEM Bot (Noordin, 2022) (Robot Literacy)

All research participants received demonstration and / or training on basic coding with scratch and Python with humanoid robots in 2023-2024. Traditionally, juxtaposition is a search for similarities or differences in educational ideologies and educational activities (Adam et al., 2015). Hence, the discussion of the findings in the present study structured in a way to present the observation and responses in a comparative manner, such as the juxtaposition of accept, enhance and transform experiences grounded on the classic Jones et al. (2009) blended learning continuum, and the polarity of positive and constructive experience. The integration of computer science and engineering with educational theory is a thoughtful and frontier method. Such research design contributes to a holistic discussion and debates response to the literatures in the research agenda. Next, the effect of intervention, risk and iterative design are analysed based on the 7 SPs. Inquiry from the experts and participants, triangulated with literature review contribute to the initial AIdagogy in AF design. We thoughtfully integrate a series of technologies and pedagogies discussed above to design the preliminary AIdagogy in AF, for a series of educational projects that facilitated and utilised robots from EUREKA Robotics Centre's standardised code of conduct and robots.

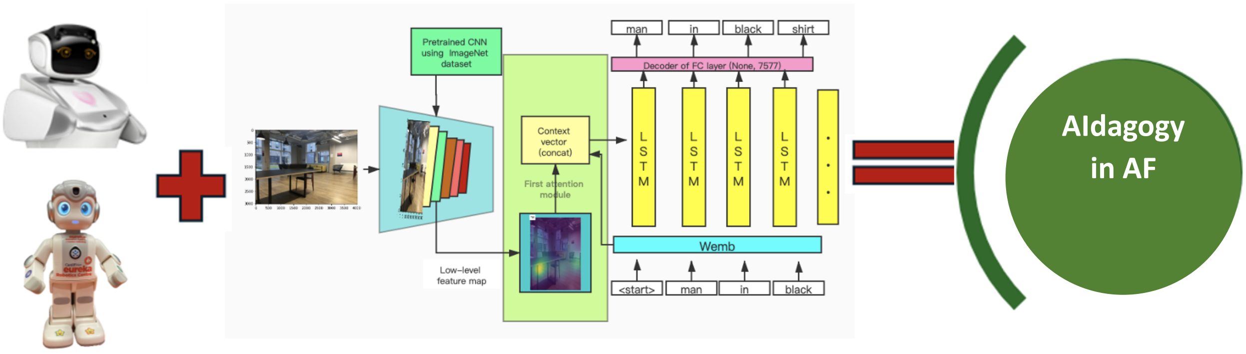

Figure 1. Technical Design for NIC in AIdagogy in AF

The technical description of Neural Image Captioning (NIC) is presented in Figure 1. Combining the assessment and feedback process between robot-human, the image-to-natural language interactivity is generated, communicating with the environment to better interact with the stakeholder, thereby changing from interaction to a bionic-companionship for a human-centred learning and teaching experience (Yang & Chew, 2021). Table 1 present the intervention in both countries for human-centered bionic-companionship AIdagogy for robot literacy:

Table 1. STEM Workshops with thoughtful integration of AIdagogy in AF between 2023-2024

	Glyncoed Primary School in Cardiff, UK	***MaryMount International Girls' School, UK***	***Girls from the Welsh Valleys at Cardiff Museum, UK***	***Cardiff Chinese Christian Church, Wales***	***TVET Malaysia Kuantan Vocational Colleges***	***Malaysia Department of State Education, Pahang***	***Methodist Church, Kuantan, Malaysia***
Teachers	2	2	2	2	6	30	3
Pupils	42	43	30	63	70	30	30
Tech-Robot Used	Nao Robot, RoboMaster and EUREKA Leg (https://x.com/glyncoedprm1/status/1811749174263841055)	RoboMaster and EZB Robot (https://x.com/eurekarobot/status/1629167113830076417)	Nao Robot & UMP STEM Bot (https://news.umpsa.edu.my/international/ump-shares-expertise-robotics-literacy-program-uk)	Python & Robot Mini (Robot Literacy) – photo is not publishable	Eureka Robot & UMP STEM Bot (Noordin et al., 2022) (Robot Literacy)	Arduino Robotics & Python Programming (Noordin et al., 2024)	Eureka Robot & UMP STEM Bot (Noordin et al., 2022) (Robot Literacy)

RESULTS AND DISCUSSION: BLENDED TECHNOLOGY AND PEDAGOGY

Debatable Experiments With 7 SPs in the UK and Malaysia

Please find the below for evidence and observations of the interventions in Wales:

1. Students at Glyncoed Primary School Cardiff are by the vivid education with intelligent robots: https://x.com/glyncoedprm1/status/1811749174263841055

2. Students from Wales Valley learn by interacting with STEM robots from Malaysia: https://x.com/eurekarobot/status/1659222233250770944

3. Students in Wales engage with STEM robots: https://x.com/eurekarobot/status/1635418874631053312

Figure 2. Case Studies in Wales – British and Malaysian

4. TVET Students hands-on with Python programming via the UMP STEM Cube robot

http://blog.ump.edu.my/hazlina/2023/08/17/python-programming-2023-4-kolej-vokasional-kuantan

5. College Students learn 2-Wheel Robot anatomy with UMP STEM BOT http://blog.ump.edu.my/hazlina/2023/08/19/mblock-programming-2023-6-sk-jengka-pusat-2

6. Methodist Church Students interact with the Robot Eureka to explore robot mechanics and anatomy http://blog.ump.edu.my/hazlina/2024/03/01/robot-literacy-24-1

Figure 3. Case Studies in Malaysia: Muslim and Christians

In Figure 2 Case Study 1-3, the impact of integrating educational robots within classroom settings across different educational levels and environments is vividly depicted in the UK. For instance, Figure 2 Case Study 1 shows the enthrallment of Glyncoed Primary School students in Cardiff with the vibrant STEAM education provided by intelligent robots, highlighting a positive reception towards technologically enhanced learning. Similarly, Figure 3 Case Studies 4-6 details the interaction of students at Kuantan Vocational College in Malaysia (Muslim) and Methodist Church Kuantan with the Robot Eureka Sanbot Model, where they explore robot mechanics and anatomy, suggesting a more hands-on engagement with technology. These experiences illustrate varied but universally constructive encounters with educational robots, underlining their potential to not just supplement but transform educational paradigms. Each case study captures unique, contextual feedback and learning adjustments that are critical in assessing the overall effectiveness and reception of educational robots in diverse educational settings. To further understand the summarized impact of these technological interventions on educational assessment and feedback, refer to Table 2. This table aggregates the observations from Figures 3 Case Studies 4-6, offering a concise view of the outcomes and the specific improvements in pedagogical practices facilitated by the introduction of robots in educational environments. Table 2 serves as a pivotal reference point, illustrating how educational robots contribute to a paradigm shift from traditional learning methods to a more interactive, feedback-oriented educational process.

Table 2. Mapping the 7SPs of AIdagogy in AF with Cross-Sectional Observatory Study

	Wales	Malaysia
SP1	At Glyncoed Primary School, NAO Robot and RoboMaster demonstrate real-time feedback on assessment standards, clarifying performance expectations for students.	At Kuantan Vocational College, the UMP STEM Bot was utilized to demonstrate effective programming, proper Arduino setup, and accurate understanding of robot anatomy. Detailed rubrics were outlined with specific criteria for each aspect of the project, ensuring that students clearly understood the expectations and standards for their work.
SP2	MaryMount International Girls' School uses RoboMaster and EZB Robot to encourage students to self-evaluate and reflect post-tasks.	During JPNP (State Education Department) sessions with the UMP STEM Cube, participants (teachers trainee) could view the display/output after coding, which provided accessible resources and feedback tools. This setup allowed students to reflect on their coding practices, robot construction, and understanding of robotics concepts.
SP3	At Eisteddfod, NAO Robot provides immediate and specific performance feedback, helping students adjust their learning strategies promptly.	With the UMP STEM Bot, participants from the Methodist Church in Kuantan received timely, actionable feedback on their programming, Arduino circuits, and robot designs, facilitating precise improvements and skill development.
SP4	At Cardiff Chinese Christian Church, Python & Robot Mini are used to facilitate communication and discussions among teachers and students (Noordin et al., 2024).	With JPNP (State Education Department), a collaborative learning environment was established by creating group activities where students (school children), teachers, and peers discussed challenges and share thoughts about their robotics projects.
SP5	At Glyncoed Primary School, Nao, JD and Xiaolongbao robots serve as motivational tools, enhancing student interest and confidence through gamified learning experiences.	At Kuantan Vocational College, workload was managed by providing balanced assessment tasks that were both challenging and achievable. Students received positive reinforcement and recognition for their progress in mastering programming and robotics skills, which supported their motivation and self-esteem

Defining AIdagogy as Preliminary Strategy for Community Development

While teachers remember the challenges involved in the uptake of AIdagogy in AF, they give the clear message that "one school one robot" is desired and for those they do not want to revert to practices without the use of AI. A continuum of integration between AIdagogy in AF grounded on 7 SPs, Yang's Companionship and Vygotsky's ZPD is proposed where feedback and robots become entwined:

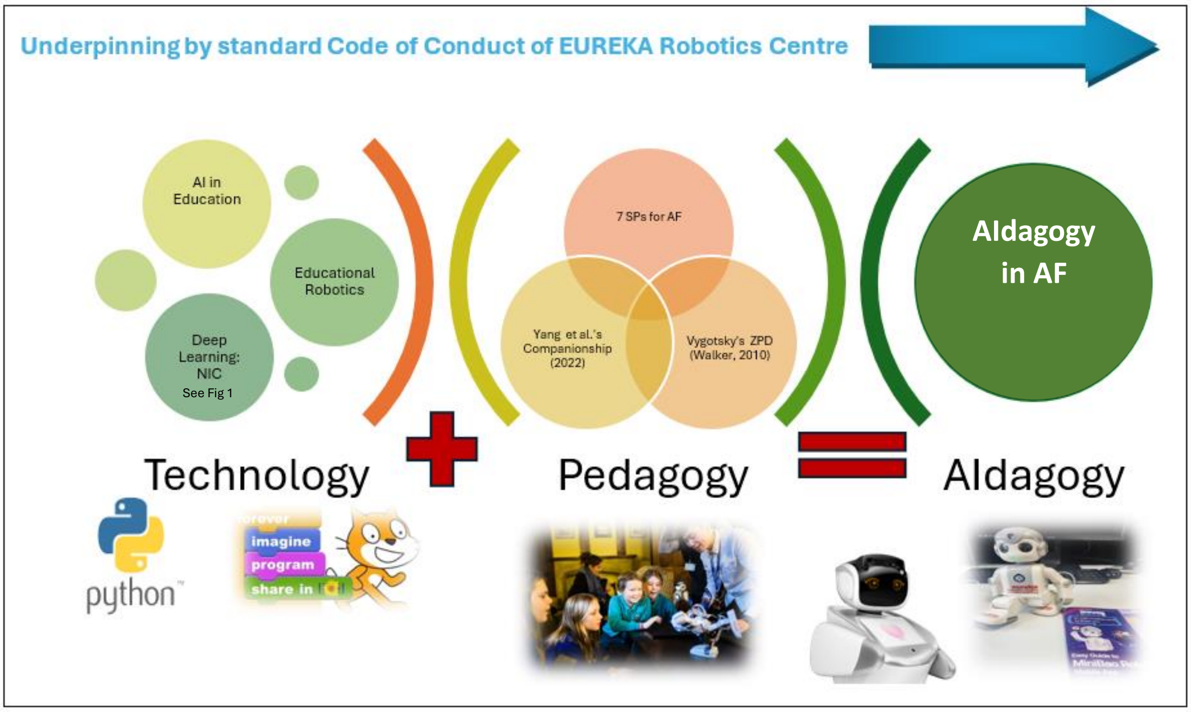

Figure 4. AIdagogy in AF Architecture

This observatory studies presents a cohesive Technology plus Pedagogy phenomenon to incorporate educational robotics with deep learning capabilities (NIC) – that increase the robot literacy when the AI is in Education (UK Government, 2023), where educators "are irreplaceable. Robots could never be a substitute for teachers' professional judgement and the personal relationship they have with their pupils." Instead, AIdagogy aims to inspire educators better by providing a strategy to adapt AI in Education: neither green or red are the best situation, but subject to the contextualized requirement of the pupils, educators, schools, and country (see Figure 5). When a wider consideration on the trans-technical aspect such as social engagement and peer-assisted companionship issues is focused, assessment and feedback would be engaged and enhanced (green and yellow in shade). The idea of fundamental transformation of assessment & feedback by AIdagogy will only be experienced by interdisciplinary computer science-engineering and social science-educational academics, and when educational-focused process with the blend of AI is in place and in a symbiotic relationship (area yellow and red).

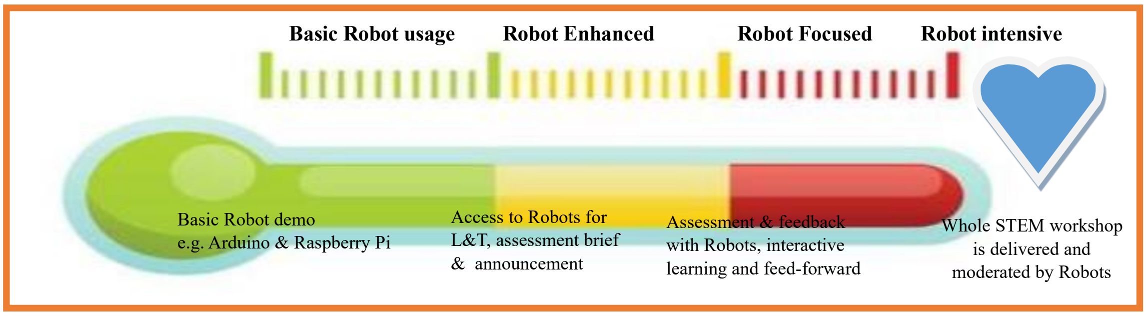

Figure 5. Preliminary Idea: Continuum of AIdagogy Strategy

It is less possible for technological-focused AIdagogy in to enhance or transform assessment and feedback practice (area red) in the next decade. Educators-pupils' dialogue within a STEM workshop might involve both feedback and instruction. Feedback provided at different points on the continuum is likely to serve different purposes and require different levels of support for students' understanding and ability to act on that feedback companied by AIdagogy in AF that anticipating to transform assessment and feedback: these types of blends enable intellectual activity that was not practically possible without AI in education (centered in pedagogy), not education in AI (centred in technology).

CONCLUSION AND LOOKING FORWARD

Inspired by the conventional Blended Learning Continuum (Jones et al. 2009), we proposed AIdagogy strategy for PIE (partnership in Education) for community development. The observatory study conclude that no one is left behind in all sessions of STEM learning with the aid of robotics. We advocate the robotics literacy among PIE community development to incorporate educational robots (at any point of the AIdagogy Strategy in Figure 5). In summary, we would report both time savings and improvement in assessment and feedback quality with educational robots. The work plays a key role for closing the research gap between AI and assessment & feedback with setting up the novel "AIdagogy" terminology, anchored with initial design. Borrowing the notion of Sadler [33] for the evolvement of assessment and feedback: if too much instrumental attention has been paid at the micro level within the traditional strategy for technology in assessment and feedback, such as 'what robots can do to help educators to construct more effective feedback, and what digital tools can do to make students more effectively access and use of the feedback provided', the field of research will have trivial impact on higher education other than instrumental benefits. AIdagogy suggests a new insight but a partial picture of the given complexity of the assessment and feedback process. However, we would assert that a larger experiment to validate AIdagogy to other PIE global partners is necessary for the 7 SPs and to realise Vygotsky's Zone of Proximal Development with robot-human companionship.

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