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Research Paper

Adopting a personal learning environment and network to strengthen students' self-directed and life-long learning attributes

Shanta Dutta[1] • Yuying Zhang[2] • Mingjing He[1] • Daniel C.W. Tsang[2]*

[1]Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China.
[2]Department of Civil and Environmental Engineering, The Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong, China.

*Corresponding author. E-mail: cedan@ust.hk. Tel: +852-3469-3133.

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Abstract. This study explored the implementation of a learner-centered interactive platform termed "Personal Learning Environment and Network (PLE&N)" in fostering a connected, deep, and personalized learning environment for accommodating students' diverse and unique learning needs. Leveraging the network-based and technology-enhanced PLE&N model introduced by the course instructor, students actively engaged with peers, instructors, experts, and professionals in a collaborative learning environment. As the successful implementation of PLE&N extensively relied on the student's contribution to the PLE&N platforms, they were rewarded with up to 10% of the total marks, which was counted toward the final grading in the subject. Through active and meaningful engagement in the PLE&N platform, students enhanced their learning horizons beyond the traditional classroom boundaries, accessing and exchanging vital and cutting-edge knowledge within their fields of interest, while effectively managing information overload by collaborative effort through PLE&N. The post-study questionnaire survey indicated that the majority of the students (80%) found useful content posted on PLE&N and highly agreed that PLE&N postings improved their understanding of the subject knowledge. Moreover, the integration of constructivist and connectivist pedagogies within PLE&N positively influenced the learning environment, enhancing students' self-directed learning attributes, as corroborated by in-depth interviews and survey responses. Impressively, at least 65% of students expressed a strong interest in adopting PLE&N for other subjects, suggesting a strong motivation towards life-long learning. These results underscore the potential of learner-driven personalized learning environments, such as PLE&N, to strengthen students' self-directed and life-long learning attributes. Insights from this research might encourage further innovative approaches in designing learner-driven personalized learning environments to strengthen students' self-directed and life-long learning attributes.

Keywords: PLE&N, RSS Feed, Constructive Learning, Connective Learning, Learner-centric Pedagogy, Higher Education.

INTRODUCTION

In this era of enhanced technology and digitization, the education system is witnessing a paradigm shift. Compared to traditional classroom-based lectures, teaching and learning methods are becoming increasingly learner-centric, multimedia-oriented, and network-based while integrating diverse e-learning resources is reshaping modern pedagogical approaches. Concurrently, freely accessible and high-quality online learning materials or open educational resources released by different universities and educational institutions worldwide (e.g., MIT Open Courseware, EdX, Coursera, etc.) have garnered immense popularity among the new generation

of learners. With the exponential increase in knowledge, wide variety of information, and ever-evolving learning tools and resources, conventional and teacher-centric learning in classroom settings might be inadequate in equipping students to remain at the forefront of learning and innovation (Kühn, 2017). To navigate the challenges posed by rapidly evolving learning environments, students are required to embrace a highly responsive and self-directed learning initiative to continuously enrich their knowledge and skills. However, students might face a formidable barrier with information overload beyond the classroom and find it difficult and exhausting to identify pertinent and reliable content to advance their self-learning capacity (Väljataga and Laanpere, 2010; Tsui et al., 2013).

Conceptualizing a Personal Learning Environment and Network (PLE&N)

Addressing the diverse learning abilities and preferences of students is crucial to ensuring the effectiveness of the tertiary-level learning and teaching system. In the modern educational landscape, the overwhelming information / resources necessitate the personalization of the learning process facilitated by emerging technologies and new web-based/online platforms. Increasingly, people are turning to trusted networks, comprising peers, professionals, and external experts in the relevant field, as knowledge is distributed across connections and networks (Dabbagh and Kitsantas, 2012; Leone, 2013). To ensure maximum educational benefits and to develop students' potential to the fullest, efficient management of learning resources and fostering meaningful interactions between student peers and course instructors become paramount. By promoting active engagement with emerging learning resources and technologies, teachers can encourage students to explore online sources to supplement their learning, thereby cultivating a responsive personal learning environment. Such an environment is commonly referred to as a "Personal Learning Environment and Network (PLE&N): (Valtonen et al., 2012; Tsang and Tsui, 2017).

PLE&N as an emerging learning concept has been elucidated by researchers considering pertinent features. For instance, in a relevant study, PLE&N was referred to as "A combination of social media-enabled systems, applications, and services which help learners to take control of their learning by aggregating, manipulating, and creating digital contents and learning artifacts, and sharing them with others." (Saadatmand and Kumpulainen, 2013). Furthermore, PLE&N was characterized as a multidimensional e-learning space that allows collaboration among individual users and relevant experts, which can be customized considering individual preferences (van Harmelen, 2006) or as a platform integrating resources, tools, and applications tailored to address the actual needs of individual learners (Ebner and Taraghi, 2010). Central to the development and advancement of PLE&N platforms is the incorporation of technology. "Advancements in technology provide a variety of tools for people to develop their own learning systems. Many of these tools include Web 2.0 tools, which are pervasive, ubiquitous, and bottom-up. Learners have the freedom and responsibilities to decide and select which tools best fit their learning purposes." (Tsui et al., 2013). Adopting PLE&N would allow students to control and manage their own learning processes and provides support to (i) set personalized learning goals and progress at their own paces, (ii) manage their self-directed learning, including personalized content and the learning process, and (ii) build networks and establish effective interactions with their peers, subject teachers, professionals, and external experts, both formally and informally, to support their learning journey and achieve intended learning goals. The perception of an interactive PLE&N is illustrated in Figure 1.

PLE&N to support self-directed and life-long learning

Self-directed learning, characterized by learners taking an active role in the learning process, evaluating their progress, and reflecting on their successes and challenges (Dutta et al., 2023), is fundamental in nurturing competent graduates. PLE&N offers a learner-centered pedagogical approach that fosters meaningful engagement, allowing students to be highly involved in knowledge construction. Instead of relying solely on traditional learning methods, such as lectures and textbooks, students can utilize customized PLE&N platforms to access relevant information. Purposeful engagement in the PLE&N platforms empowers every student to remain updated on important knowledge and state-of-the-art information aligned with their personalized needs and interests. Higher engagement with the learning process might help students to obtain skills to manage their own learning and achieve the desired learning outcomes (Nganji, 2018). Besides, all students can co-learn from the information received on the PLE&N platforms and co-create knowledge, which is essential to stimulate their self-directed learning behavior. Consequently, students might be instilled with a heightened sense of responsibility by playing an active role in designing the PLE&N platform (Lim and Newby, 2020). However, to maximize the benefits of this pedagogical approach, it is imperative to equip students with digital literacy and familiarize them with the self-directed learning process necessary for building and utilizing the PLE&N platform effectively (Haworth, 2016). Moreover, life-long learning has gained considerable attention in educational research. European Commission (2002) defined life-long learning as "All learning activity undertaken throughout life, with the aim of improving knowledge, skills and competencies within a personal, civic, social and/or employment-related perspective". Although the concept of

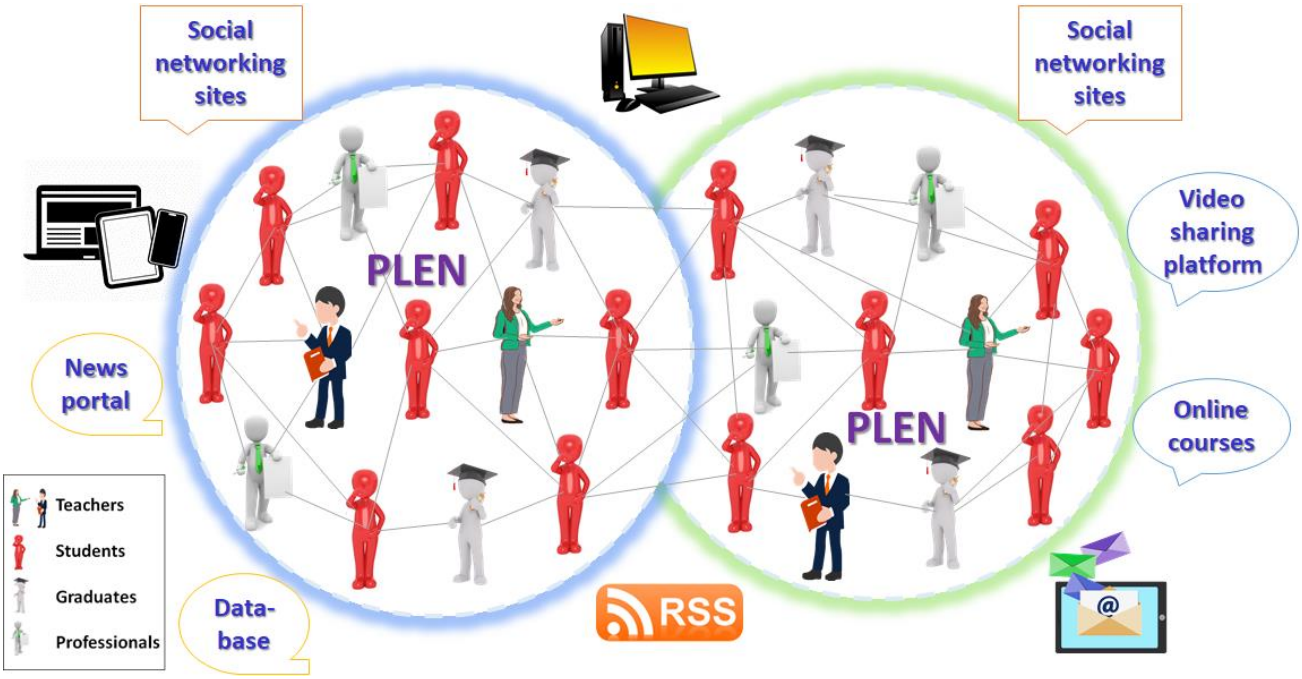

Figure 1. Visual presentation of a personal learning environment and network (PLE&N).

life-long learning is widely acknowledged, its application in tertiary education, particularly with respect to PLE&N, has been relatively underexplored. Considerable flexibility and personalization offered by PLE&N could be conducive to life-long learning. Tsang and Tsui (2017) explained the prospect of PLE&N for life-long learning, "With the participation of enthusiastic external parties from enterprises taking the advisory roles, students will be convinced that the new, information technology-enabled learning environment they use in courses is in fact also for the future and that they can continue to refine, enhance, expand and change throughout life as they wish according to their needs and personal preferences.". Briefly, PLE&N has the potential to promote life-long learning by offering a flexible and customizable platform that empowers learners to continuously acquire knowledge and skills throughout their lives, meeting the evolving demands of the dynamic world.

Integrating constructivist and connectivist pedagogy with PLE&N

To achieve intended learning outcomes and foster student-centric learning experiences, the integration of constructive and connective learning approaches within PLE&N holds immense potential. Constructivist pedagogy implies that knowledge is being constructed by an individual based on her/his own experiences and perceptions rather than simply acquiring it via memorization or transmission (Bates, 2019). Constructive learning inspires learners to apply their learning to real-life scenarios, thus creating meaning and a deep understanding through experiences. Learners can develop unique interpretations of the external world based on their individual experiences and interactions, contributing to a personalized and meaningful learning process (Dutta et al., 2022). In contrast, connective pedagogy emphasizes cultivating skills to establish, expand, and navigate networks of knowledge and ideas that can be distributed throughout the network. Connective learning entails establishing connections that enable the learners to acquire new knowledge and expand their understanding continuously. "Connectivism is driven by the understanding that decisions are based on rapidly altering foundations. New information is continually being acquired. The ability to draw distinctions between important and unimportant information is vital. The ability to recognize when new information alters the landscape based on decisions made yesterday is also critical." (Siemens, 2017). The concept of PLE&N is underpinned by accurate and updated knowledge distribution throughout the network, which may allow for better collaboration and enhance communication between educators, students, professionals, etc. and facilitate a connective learning environment. "In a typical PLE&N which is student-centered, a student develops deep cognitive skills for problem solving and collaborative work with others as well as acquires those qualities or attributes (e.g. self-regulated learning attitudes) required for life-long learning after graduation" (Tsang and Tsui, 2017). Hence, developing a PLE&N platform integrated with constructivist and connectivist learning approaches could be a potential pedagogical approach to nurture desirable graduate

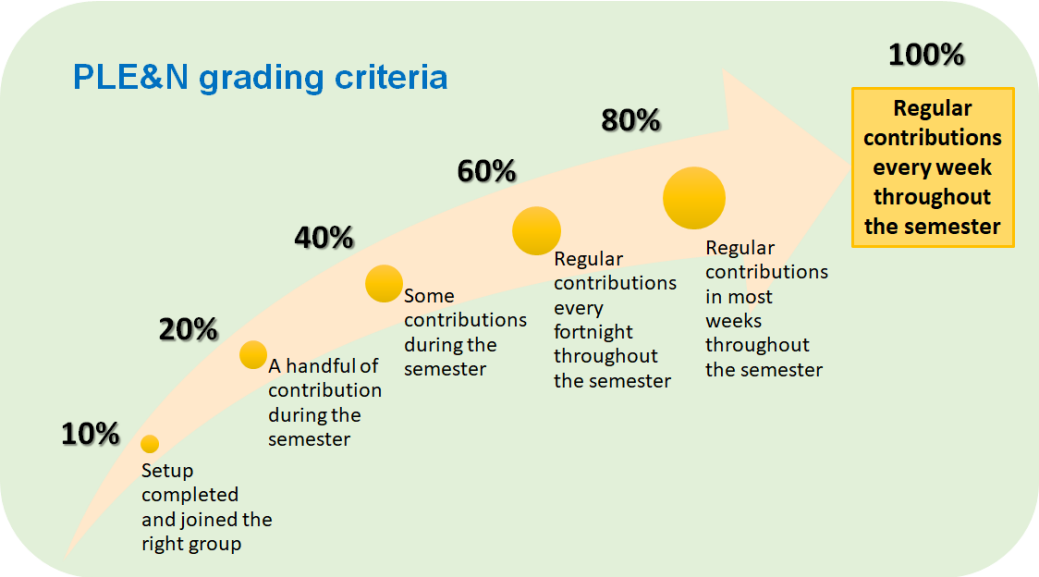

Figure 2. Illustration of grading criteria for students' contribution to the PLE&N platform.

attributes among students at the university level.

Scope of this study

This study aims to explore and implement the PLE&N as a pedagogic approach to enhance students' self-directed and life-long learning attributes through collaborative contributions. The objectives of this study were to (i) design and deploy a responsive PLE&N to enhance student's self-directed learning ability through recognizing appropriate learning contents, tools, and resources, (ii) implement the constructivist and connectivist learning theories/pedagogies with PLE&N for improving student's problem-solving skills and critical thinking skills, (iii) foster student's life-long learning behavior through continued interactions among students with peers, teachers, and professionals beyond the classroom by using the PLE&N platform, and (iv) evaluate students' learning enhancement considering points mentioned above through self-assessment by students end of the study.

METHODOLOGY

Developing the PLE&N platform

A customized PLE&N platform was developed for this study, catering to undergraduate engineering students enrolled in the course "Water and Waste Management" at The Hong Kong Polytechnic University. A total of 166 students participated in this research for 10 weeks and contributed to the PLE&N platform in collaboration with the course instructor, tutors, graduates, and experts/professionals in the field. To enable information exchange and foster collaboration, students were instructed to set up an RSS reader account, i.e., Inoreader, as well as create an account on a social networking site, i.e., MeWe. Students should join a specific group in a MeWe, which was created by the course instructor for the respective participants enrolled in the course to facilitate posting information and building the knowledge repository. Besides, RSS feeds helped to bring new/updated information to students on a regular basis, thereby saving time and effort from doing active searches for the needed information. Initially, RSS feed relevant to the subject were provided to the students by the course instructor, students were guided to find relevant feeds and personalize them based on their specific learning interests/needs, individual learning styles, and personal preferences for learning resources. Further, students could select relevant and interesting information, news, videos, research findings, etc., from related websites, other social networking sites, video-sharing platforms, etc., and afterward share the topics by posting and discussing in the respective MeWe group.

Evaluating PLE&N contributions

Students' performance with respect to PLE&N was directly evaluated based on their contributions to the PLE&N platform. To stimulate students' performance and spontaneous use of the PLE&N platform, their contribution was rewarded with 10% of the total marks for the given subject, and the obtained marks were counted towards the final course grading. An Illustration of grading criteria for students' contribution to the PLE&N platform is given in Figure 2. Students obtained 10% of the total allotted marks (for PLE&N) just by completing the recommended setup

and joining the right group in MeWe. Subsequently, additional marks could be obtained (up to 100%) by contributing to the PLE&N platform weekly during the study period. The requirements for PLE&N contributions and details of the grading criteria were thoroughly explained to the students, and the whole process was demonstrated by the course instructors and tutors at the beginning of this study. Moreover, a brief discussion along with a Q&A session was held every week during the 10-week study period to facilitate the adoption of the PLE&N and stimulate students' participation. End of the study period, each student prepared a PDF file summarizing all their PLE&N contributions and submitted it to the instructor for review and grading.

Evaluating students' learning experiences associated with PLE&N

To evaluate the influences of PLE&N on students' learning experience, two different approaches, i.e., questionnaire survey and semi-structured interview, were applied in this study. These approaches mainly focused on gauging students' perception of various aspects of PLE&N and their attitudes toward constructive, connective learning contributing to self-directed and life-long learning. Specific close- and open-ended questions were incorporated in the post-project questionnaire surveys and semi-structured interviews to evaluate the aspects mentioned above.

Questionnaire survey

The questionnaire survey was conducted at the end of the study period with participating students on a voluntary basis to self-assess their learning experiences associated with PLE&N implementation and solicit their feedback on relevant issues. As an appreciation of their contribution, a bonus mark (2%) was provided to the students who participated in the survey. The questionnaire (Table 1) was mainly categorized into four sections. Section-1 of the questionnaire concentrated on assessing students' perception of PLE&N in the subject, focusing on the relevancy and usefulness of PLE&N contents and the overall impression of the PLE&N platform. Questions in Sections-2 and 3 were designed to evaluate students' constructive and connective learning attributes, respectively, in relation to the PLE&N implementation, while Section-4 intended to assess the perceived influence of peer learning and feedback on students' self-directed learning attitude and skill advancement. Furthermore, apart from the closed-end questions, Section-2 to 4 included open-ended questions to solicit students' feedback and suggestions for further learning enhancement through PLE&N. For questions included in Section-1, students were asked to rate their learning experiences on a scale of 1 to 5, and the explanation of each rating was given based on the specific question. For instance, in the case of Q2, "Has the content improved your understanding of the subject knowledge?", the rating scale was defined as given below, 1 = Very little, 2 = Little, 3 = Somewhat, 4 = Considerably, 5 = Very much. However, for Section-2-4, a seven-point Likert response scale was adopted to quantify students' self-assessment in response to the specific point in the questionnaire, with 1 signifying "Not Confident", 4 signifying "Neutral", and 7 signifying "Very Confident". A mean score of response was calculated for each question for further interpretation.

Semi-structured interview

Face-to-face semi-structured interviews were conducted with selected groups of students who voluntarily participated in this study to solicit qualitative feedback regarding PLE&N adoption and better understand students' learning experiences in this study. Generally, the interview approach was designed with reference to the existing technique reported in the literature (Tsang and Tsui, 2017; Mak et al., 2019), ensuring a comprehensive and systematic exploration of the research objectives. A total of eight open-ended questions (Table 2) were raised during the interview, primarily focusing on PLE&N adoption, students' engagement in self-directed learning, the practicality and benefits of the PLE&N, and skill advancement. Follow-up questions were raised when needed to obtain deeper insights into students' perceptions and experiences. Students were also encouraged to share their opinion and suggestion for further enhancement of learning experiences, peer learning process, and intended learning outcome of this course. With proper consent from students, their responses and conversation with the interviewer were recorded during the whole interview period and subsequently processed following audio transcription. Students' views and thoughts are presented in their own words in the later section of this article (after minor corrections when necessary).

RESULTS AND DISCUSSION

Adopting the PLE&N platform: Implementation and observations

Following the completion of the required PLE&N set up by students, the course instructors introduced selected RSS feeds comprising relevant learning contents and resources, which facilitated a deeper understanding of how educational/professional concept is being manifested in the real-world context and allowed students to stay updated on current trends and technological innovations in specific fields of interest. Considering guidelines and related examples illustrated by the instructor and tutors,

Table 1. Questions designed for the survey regarding PLE&N adoption and usefulness.

Section 1: PLE&N	
Relevancy	Q1: How relevant do you find the content posted on PLE&N to the subject?
Usefulness	Q2: Has the content improved your understanding of the subject knowledge?
Overall impression of PLE&N	Q3: Does PLE&N provide up-to-date information about the subject?
	Q4. Does PLE&N provide you with knowledge beyond the syllabus?
	Q5: Has the content posted on PLE&N assisted you in the subject assessment (i.e., homework, test, etc.?
	Q6: How much do you want other subjects to operate on PLE&N?
Section 2: Constructive Learning	
Q7: You can create and adjust your own learning behavior based on past experiences.	
Q8: You can apply what is learned in the lectures to better understand the real world.	
Q9: You can create meaning and understanding through active learning activities.	
Q10: You can make flexible use of pre-existing knowledge to formulate engineering solutions in different situations.	
Q11: You can transfer the acquired engineering knowledge and skills to solve new problems.	
Q12: Please provide your feedback and suggestions for enhancing your constructive learning experience through active engagement via PLE&N.	
Section 3: Connective Learning	
Q13: You can acquire new knowledge through a network of different ideas from online resources.	
Q14: You can identify uncertainties or unknown parameters (i.e., knowledge gaps) to facilitate your self-directed learning.	
Q15: You can learn by connecting different and specialized information sources.	
Q16: You can connect, build, and expand the knowledge network during your individual learning process.	
Q17: You can ensure accurate and up-to-date knowledge acquisition for your own learning activities.	
Q18: Please provide your feedback and suggestions for enhancing your connective learning experience and ensuring effective collaboration among students, teachers, and professionals via PLE&N.	
Section 4: Peer Learning & Feedback	
Q19: You can find ample opportunities to connect and collaborate with peers as well as professionals.	
Q20: Peer learning through different posts on PLE&N can help you connect new and relevant information.	
Q21: You can construct new knowledge by using feedback, Information, and learning resources posted by peers.	
Q22: Peer feedback and comments can stimulate your active and self-directed learning attitude.	
Q23: Peer feedback and comments can foster your critical thinking and problem-solving skills.	
Q24: Please provide your feedback and suggestions for enriching your experience in the peer learning process and associated benefits.	
Q25: Do you have any other comments regarding overall learning enhancement and intended learning outcomes?	

students further explored relevant RSS feeds and contributed to the MeWe platform on a weekly basis. The course instructor regularly monitored their contribution and facilitated interactive discussions in the classroom to ensure students' active engagement and a practical and effective learning system through PLE&N. Students co-created the content and learned from each other through peer interactions, annotations, comments, and discussions on the PLE&N platforms.

To encourage students to proactively and efficiently use the PLE&N platforms, their contributions were incentivized through a grading system integrated into the subject assessment, as previously discussed. Through regular exercises of identifying and evaluating appropriate learning contents and the latest resources, together with peer learning with the networks, students were able to improve their digital literacy skills to thrive in the era of emerging information. Furthermore, by observing students' postings and discussions, teachers received additional feedback from students on an ongoing basis and could identify and adjust her/his teaching style to address any shortfall or areas that need further clarification. The rationales and assessment rubrics (Figure 2) were elaborated by the course instructor and tutors at the beginning of the course as well as a weekly follow-up was arranged with students to remind them of the grading criteria. Students could contribute to the PLE&N platform in three different ways, (i) sharing relevant

Table 2. Questions designed for the semi-structured interview.

Semi-structured interview: Learning enhancement through deploying PLE&N
Q1: How practical do you find the contents posted on the PLE&N platform in terms of your awareness of the latest technology and emerging concerns in your field of study?
Q2: How does PLE&N help you to improve your understanding of the subject and provide new knowledge beyond the syllabus? If possible, please name a few examples.
Q3: What is your opinion about using PLE&N to facilitate active engagement for enhancing your experience in constructive learning (construct new knowledge based on past experiences, transfer the acquired knowledge and skills to solve a new problem in real life, etc.)?
Q4: What have you done to make use of PLE&N for connecting different and specialized information sources to expand your knowledge network? Does it help to improve your experience in connective learning?
Q5: How beneficial do you find PLE&N in terms of enhancing your professional skills to identify uncertainties or unknown parameters (i.e., gaps in knowledge) and promote your self-directed learning?
Q6: Do you find it helpful to have peer feedback and comments on PLE&N to foster your critical thinking and problem-solving skills?
Q7. Please provide any suggestions that you may have for enriching your experience in this peer learning process and the associated benefits.
Q8: Do you have any other comments regarding overall learning enhancement and intended learning outcomes of this course?

information by creating a new post, (ii) engaging in thoughtful discussion and comments on existing posts, and (iii) reposting an existing post to/from other groups. The total number of contributions by an individual student, e.g., locating appropriate learning resources and sharing them in the PLE&N platform, responding/commenting on earlier posts by others, as well as leading interactive discussions among peers and others (i.e., graduates, experts/professionals, etc.) were counted for marks (i.e., continuous assessment) and accumulated marks contributed to the subject grading. Students were highly encouraged to respond to other students' postings and discuss through the PLE&N platform, in addition to creating new postings every week. As explained by the course instructor beforehand, students' contributions were not rewarded with marks in case it was too brief (e.g., a yes, a tick) or if they randomly posted some information without providing any original expression. Full mark was provided for relevant posting, which was articulated with their own reflection along with reference to the subject materials and/or the academic fields of personal interests. Besides, dozens of postings towards the end of the semester merely for fulfilling the grading requirements were not favorably appraised. Both frequency and quality of students' postings/comments/responses were considered together toward PLE&N assessment and subject grading. A notable outcome was the consistent and concerted efforts invested by the majority of the students throughout the semester, indicating their dedication to the PLE&N platform and its benefits. Remarkably, 65% of the total participants achieved 100% of the allotted marks for the PLE&N in the subject, underscoring the positive impact of the PLE&N platform on fostering active engagement and co-learning. Moreover, the PLE&N environment facilitated meaningful connections among students, encouraging interactions with peers, professionals, and experts to seek advice, identify the right information, and collaboratively enhance the learning experience. This aspect will be further explored in subsequent sections. Overall, adopting the PLE&N grading system proved to be an effective strategy in promoting student involvement, collaborative learning, and the development of essential skills necessary for life-long learning.

PLE&N influence on students' learning experience

The impact of PLE&N implementation as a pedagogical approach on students' learning enhancement was assessed through post-project questionnaire surveys and semi-structured interviews. In total, 123 students (~74% of the total enrolled students in the course) voluntarily participated in the survey questionnaire. In the questionnaire survey, 80% of students found the content posted on PLE&N highly relevant to the subject they are studying (Figure 3a). Remarkably, 98% of the student respondents expressed varying degrees of agreement on the usefulness of PLE&N content in improving their understanding of the subject knowledge (Figure 3b). Among them, 83% of students rated with considerably high to very high scores (score: 4-5) for the usefulness of PLE&N content, demonstrating its significant impact on enriching their learning experiences. These results are encouraging and are comparable with a relevant study on PLE&N by Tsang and Tsui (2017). In-depth insights into students' experiences with PLE&N were further gained through semi-structured interviews. Students described

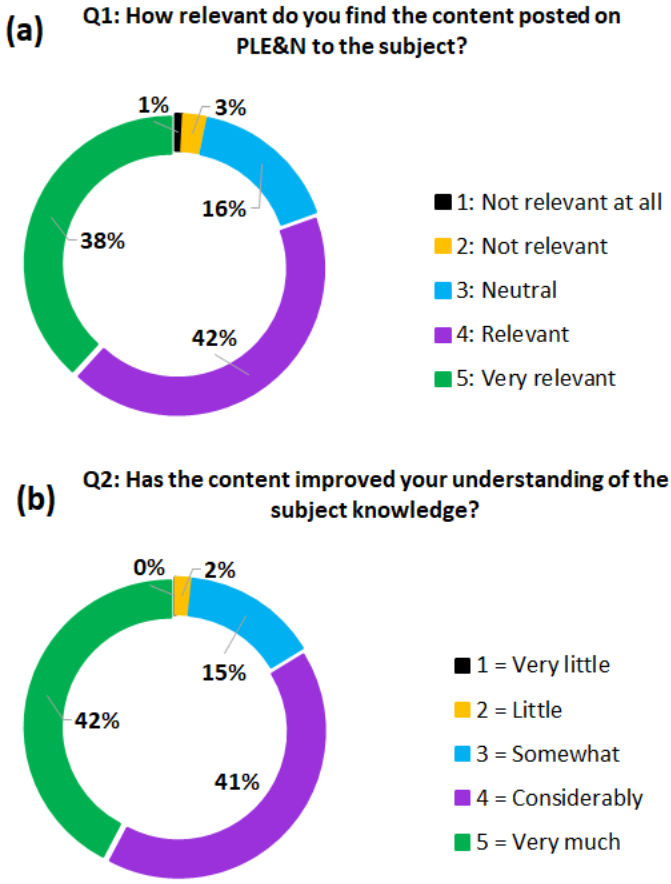

Figure 3. Students' perception of relevancy and usefulness of content posted on PLE&N.

the content posted on PLE&N as diverse yet highly useful, enabling them to access relevant news and research articles related to the latest technological development (e.g., food waste treatment, waste-to-energy conversion, green construction, plastic waste valorisation, etc.). This access to up-to-date information stimulated their active learning and provides them with a broader perspective on the subject matter. One of the students remarked, "Through the PLE&N platform, I can share knowledge that I am interested in or good at. It will have a wide range of dissemination and spread to others quickly via the platform, and others may also find it useful. It can help us to find information on new technologies.". Besides, students indicated that it was their first time using this kind of sharing platform (PLE&N) in an academic environment, despite its similarity to other social networking platforms.

Generally, students expressed a positive overall impression of PLE&N implementation in this course. Though they found a considerable number of PLE&N postings were beyond the syllabus, they found this aspect to be highly beneficial for enhancing their knowledge, particularly in understanding real-world scenarios. The PLE&N platform supplemented classroom learning and provided them with ample opportunities to explore diverse yet relevant topics. The survey results indicated that approximately 45% of students highly agreed that PLE&N provided them with up-to-date information about the subject (Figure 4a), with an additional 36% of respondents considering it to be considerably up-to-date. Interestingly, 99% of the students variably agreed that PLE&N delivered valuable knowledge beyond the syllabus (Figure 3b). Over 90% of students thought PLE&N assisted them in the subject assessment (i.e., homework, test, etc.) (Figure 4c) to some extent, which also reflected direct benefits associated with PLE&N for improving their learning experiences. Some of the students' opinions from the interview are quoted below;

"We can broaden our knowledge and make up for the lack of learning in class."

"We can discover knowledge beyond the lecture, and we can discuss it at any time if we encounter problems during our studies."

"Although the content posted by everyone revolves

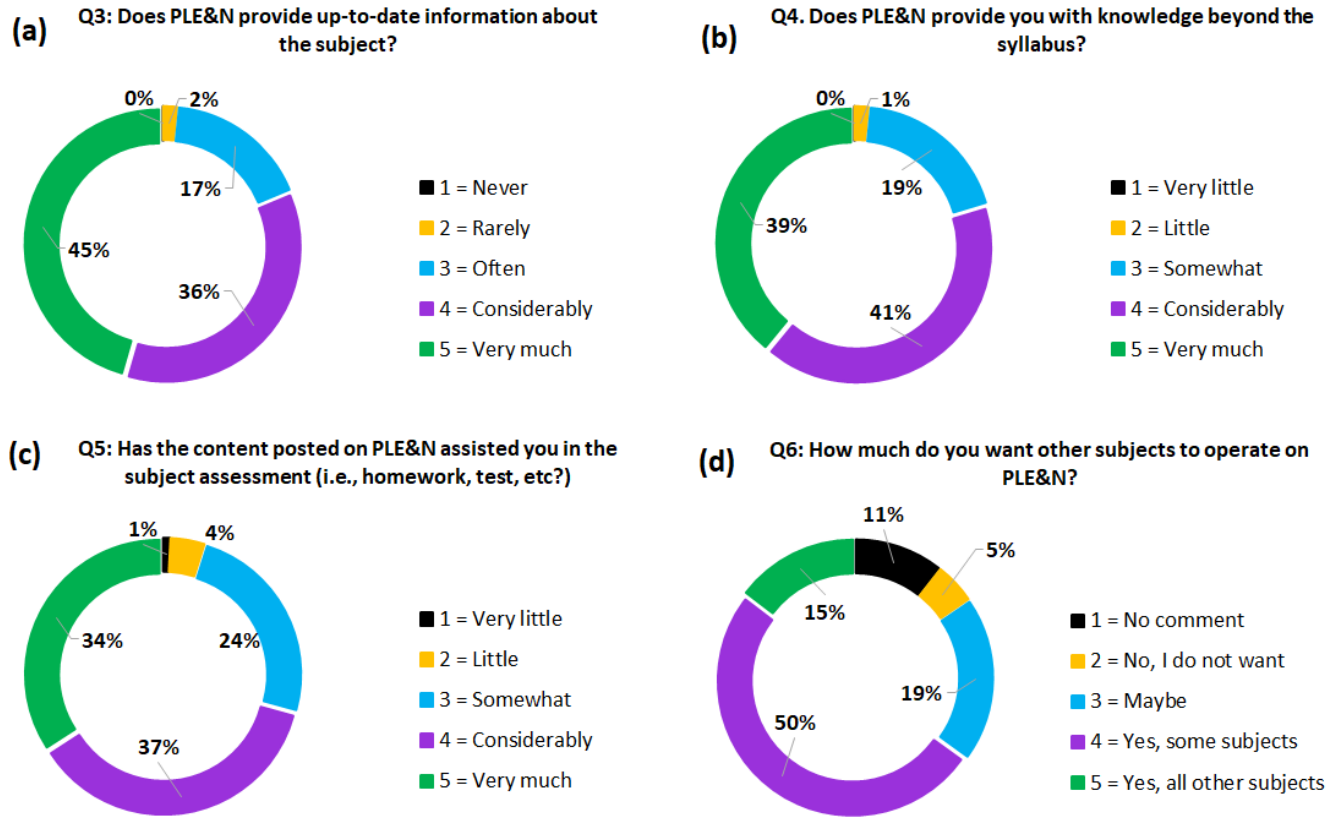

Figure 4. Overall impression of students regarding PLE&N.

around environmental issues and pollution control, everyone has a different perspective, which is very comprehensive. For example, the content shared by some students revolves around the treatment technology of pollutants, while others pay more attention to pollution incidents."

"This platform provides more knowledge beyond our lecture, such as information and articles from YouTube and other sites on the internet. This information will be much more updated and we will get more benefits from it." Moreover, the survey indicated that 65% of the student respondents expressed strong interest in adopting PLE&N in at least some subjects during their study (Figure 4d), while the other 19% might be willing to adopt PLE&N to some extent. This finding is inspiring as it reflects students' enthusiasm to broaden their learning horizon and embrace a life-long learning attitude, indicating PLE&N's potential as a valuable tool for fostering lifelong learning among tertiary-level students.

Constructive and connective learning experiences through PLE&N

The students demonstrated a strong agreement regarding their enhanced constructive and connective learning attributes related to PLE&N during their self-assessment in the survey. Constructivist pedagogy emphasizes the flexible use of pre-existing knowledge to create new knowledge, creating meaning and understanding through experiences, and consequently applying the acquired knowledge to solve problems in real scenarios (Bednar et al., 1991). Therefore, students must be able to relate to PLE&N learning activities with their previous knowledge and experiences. Interestingly as revealed by the survey, around 80% of students indicated a high degree of confidence (score: 5-7) (Figure 5a) when questioned whether they can create and adjust their learning behavior based on past experiences (Q-7). Besides, 82% of students expressed high confidence when asked if "You can apply what is learned in the lectures to better understand the real world" (Q-8). They could make flexible use of pre-existing knowledge (80% of the students rated with a score of 5-7 for the category) to formulate engineering solutions under different situations (Q-10). Notably, a higher number of students (84%) very confidently responded that they could create meaning and understanding through active learning activities on PLE&N (Q-9). One student remarked, "Our understanding of knowledge will be deeper as we are involved in PLE&N. We might be unfamiliar with the knowledge only by

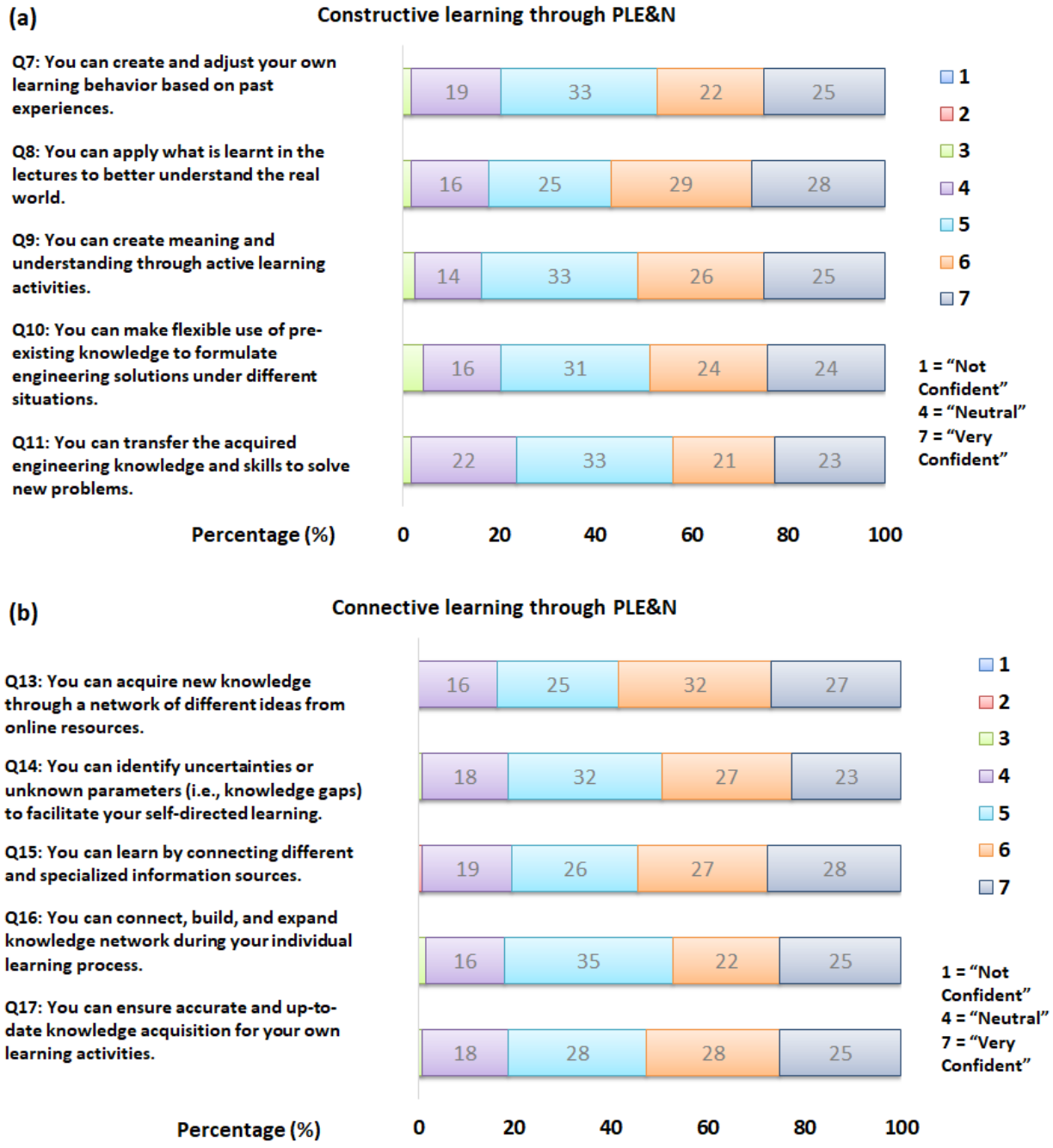

Figure 5. Students' self-assessment of (a) constructive and (b) connective learning through PLE&N.

listening to the professor's lectures, yet we can deepen our understanding by checking it ourselves in the PLE&N." These promising results suggest that PLE&N inspired students as independent and proactive learners and stimulated their thoughts. The in-depth interview also revealed that a considerable number of students perceived the PLE&N platform as a great motivation to engage themselves in active and self-directed learning, while some others merely used the platform only for this course to fulfill the grading requirement, which might be expected in a large class setting. About 24% of students indicated either skeptical or neutral views when questioned if "You can transfer the acquired engineering knowledge and skills to solve new problems" (Q-11) (Figure 5a), though the majority of the students showed confidence in this regard. Additional guidance and motivation would be required to improve students' engagement and inspire them to make the best use of the PLE&N platform.

As indicated by the survey, a high percentage of students responded (84%) with high confidence (score: 5-7) when asked if "You can acquire new knowledge through a network of different ideas from online resources" (Q-13), while 82% of students felt confident that they could connect, build, and expand knowledge network during their individual learning process (Q-16) (Figure 5b). The survey also inquired students whether "You can identify uncertainties or unknown parameters (i.e., knowledge gaps) to facilitate your self-directed learning" (Q-14), and in this case, 81% of students demonstrated high confidence. Students articulated how they found PLE&N useful in terms of enhancing their professional skills to identify uncertainties or unknown parameters (i.e., gaps in knowledge) and helped to promote their self-directed learning. Some of the students' comments/opinions from the interview are quoted below;

"PLE&N platform provides a chance for us to find environmental news and related information. I think it was a great help to enhance our professional skills."

"I think it is quite useful. For example, we are learning about waste and wastewater in this course. When we need to find answers to some related questions or solve any problem, we can search for information and share on the PLE&N platform, which helped to improve our research skills."

"PLE&N made my self-learning time more flexible. Sometimes, there are too many assignments from different courses in a single week, The PLE&N platform allowed me to conduct research in advance on some interesting topics and flexibly learn more relevant knowledge."

Students could ensure accurate and up-to-date knowledge acquisition for their self-directed learning activities (Q-17) as 81% of students rated with high confidence. The mean scores for different categories under connective learning included in this study ranges from 5.4 to 5.7, which is slightly higher than the scores achieved in our previous study (mean scores ranged from 5.1 to 5.4) (Dutta et al., 2022) where students' connective learning enhancement was evaluated after completion of a problem-based learning assessment. A higher score achieved in this study suggests PLE&N might be a more effective pedagogic approach in boosting students' connective learning attributes. "Learning in connectivism terms is a network phenomenon, influenced, aided, and enhanced by socialization, technology, diversity, the strength of ties, and context of occurrence." (Tschofen and Mackness, 2012). The connectivist pedagogy implies knowledge as a network of ideas and defines learning as a process of connecting relevant information sources, which aligns well with the network-based and technology-enhanced PLE&N concept. Usually, when students need relevant information on new technologies or searching for answers to some problems, they would search on the internet or look into popular social networking sites and video-sharing platforms. However, in this course, students made good use of the PLE&N platform to find relevant information. Through discussion during the interview, students appreciated having a dedicated PLE&N platform in this course, which allowed them to find and connect with updated and specialized nodes of information, expanding their knowledge network effectively.

In summary, PLE&N implementation positively influenced students' constructive and connective learning experiences. It facilitated the application of past experiences, understanding of real-world applications, and active learning engagement. Moreover, students found PLE&N valuable in acquiring new knowledge, identifying knowledge gaps, and expanding their knowledge networks through meaningful connections with diverse resources and ideas.

Peer Learning and feedback through PLE&N

Peer learning and feedback are important aspects of the PLE&N implemented in this study. Students' self-assessment in view of peer learning through PLE&N was assessed through the survey and the interview. Approximately 80% of students demonstrated high confidence when assessing themselves for different questions included for peer learning (Figure 6). A maximum of 86% of students rated with confidence when asked if peer feedback and comments fostered their critical thinking and problem-solving skills. Similar opinions were also attained during the student interview, which further validated the survey findings though a few students showed their disappointment for not receiving peer comments as expected. Relevant students' remarks are quoted below.

"Peer comments can provide valuable understanding from different angles and make our thinking more comprehensive."

"We can learn knowledge in different areas based on the feedback from others, who have different knowledge backgrounds."

"Because I didn't receive much feedback from peers, I think it is a little bit helpful to push me forward. I think it is because there are too many posts."

"Having peer feedback and comments is very helpful. When I share some environmental news or information on the PLE&N platform, I may focus on only a particular section of the news/information. Then review and comments from other students on my posting provide me with other viewpoints. Peer comments make me go through other relevant information or perspectives that I

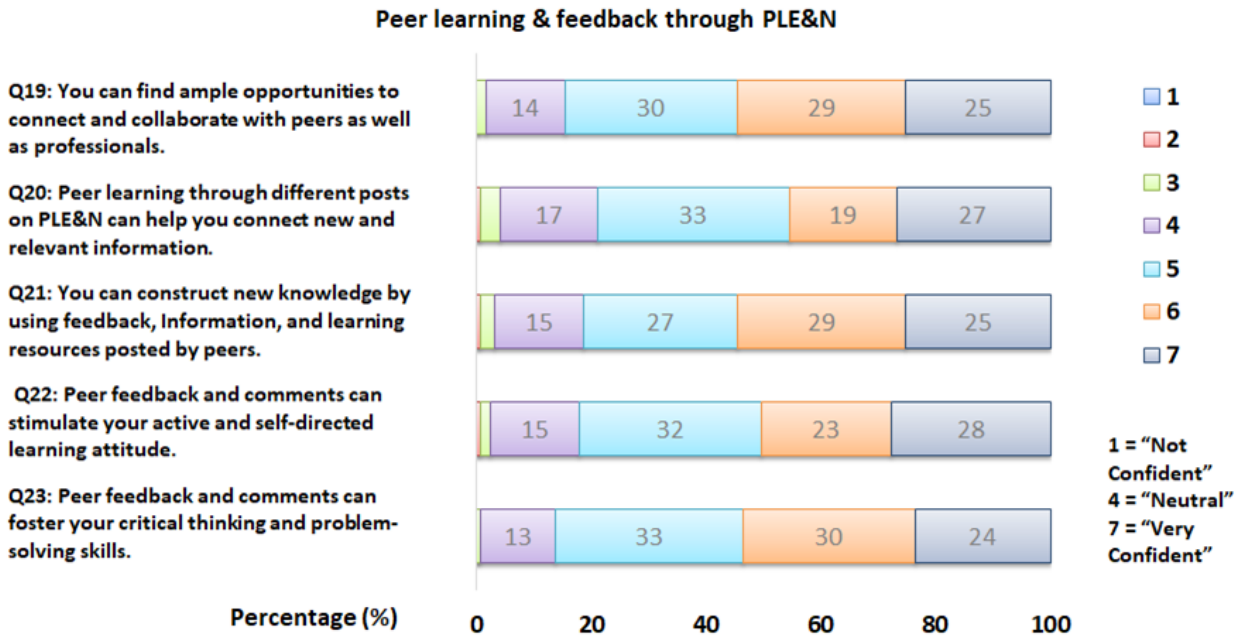

Figure 6. Students' self-assessment of peer learning through PLE&N.

should think more about."

Students' comments and discussion during the interview also reflected their motivation to equip themselves as a life-long learner. Leone (2013) in a relevant literature on personal learning environment illustrated vital features of the life-long learner profile, i.e., active, cooperative, creative, critical, strategic, and autonomous. PLE&N created ample opportunities for students to incorporate active participation, collaboration, and contribution to the shared knowledge base. Moreover, it enabled them to practice self-reflection, scrutinize peers' posting, and recognize the need to evaluate their own learning from peers' perspectives. For instance, a relevant remark from a student is mentioned below, "Sometimes, we make a post on the PLE&N platform, we just focus on the topic and share our thoughts. If other classmates are asking why we chose the topic and how it is related to our study, then we tend to think deeper about the information/news and reflect more on what it is talking about. It is interesting that peer feedback lets us consider how things work in the real world and motivates us to find additional information to satisfy our thoughts or solve related problems." Additionally, students shared views and suggestions for enriching their experience in this peer learning process and enhancing the associated benefits of PLE&N. Some of them suggested inviting students to conduct a brief presentation to share their learning resources, while others recommended including more sessions for discussion among students, the instructor, experts, etc., where students would be able to focus more on research topics they want to explore. Besides, they are interested in expanding their knowledge network even more, which is an important point that should be considered further in future study design. Related students' comments are quoted below;

"PLE&N platform introduced in this course was great. Yet, we may join some other related groups to connect to more professionals that can help to get more information to build the knowledge needed for our future careers."

"Apart from focusing only on academic essays, we may try learning from diverse sources relevant to our field. I saw some of our classmates posted some interesting pictures and findings on the PLE&N platform that are related to our field of study. I think this is also a good way to get more experience and find some topics close to our daily life or our community and find a way to fit it into our academic environment."

"To improve our learning experience, we should not only focus ourselves on academic topics within the subject. It is important to learn more for improving the environment for the community and our life."

Besides, the majority of the students mentioned that a high fraction of marks allotted to the PLE&N (10% of the total grading) in this course highly motivated their contribution. In contrast, a group of students shared a different view that everyone's enthusiasm would be higher if PLE&N contributions were not counted in final grading rather a bonus mark was given to reward students' posting and discussions. However, there is still a lot of room for tuning the PLE&N system for its future application in higher education. Findings and observations from this study

might help assess related prospects and constraints, and design fruitful PLE&N projects in the future.

CONCLUSION

This educational research project successfully implemented a PLE&N platform, providing a flexible and student-centered learning approach that catered to individual learning needs and fostered meaningful engagement in studies. Collaborating with peers, the subject instructor, experts, etc., students explored relevant, interesting, and valuable learning content, addressing the challenge of information overload in the digital age of abundant e-learning resources. A high agreement was observed among the majority of the students regarding the relevancy and usefulness of the posted contents, and overall impression of PLE&N. Moreover, constructive and connective learning elements integrated with PLE&N helped students to strengthen their self-directed and life-long learning attributes, as evidenced in this study. However, there is scope for further improvement in the PLE&N design and learning practices to further enhance student involvement and learning outcomes. Nonetheless, positive outcomes perceived in this study highlight the potential of PLE&N to shift the learning paradigm from a traditional teacher-centric approach to a learner-centric and peer-based approach. Such a shift can significantly enhance students' learning quality and professional competencies, empowering them to thrive in the dynamic and ever-evolving educational landscape.

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REFERENCES

Bates AW (2019). Teaching in a Digital Age - Second Edition.

Bednar AK, Cunningham D, Duffy TM, Perry JD (1991). Theory into practice: How do we link?

Dabbagh N, Kitsantas A (2012). Personal learning environments, social media, and self-regulated learning: A natural formula for connecting formal and informal learning. Internet High. Educ. 15:3-8.

Dutta S, He M, Tsang DCW (2022). Problem-based learning as an assessment: Enhancing students' connective learning and constructive learning, J. Educ. Res. Rev. 10(6):83-92.

Dutta S, He M, Tsang DCW (2023). Reflection and peer assessment to promote self-directed learning in higher education. J. Educ. Res. Rev., 11(2):2384-7301.

Ebner M, Taraghi B (2010). Personal learning environment for higher education – a first prototype. In Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications. pp. 1158-1166.

European Commission (2002). European report on quality indicators of lifelong learning. Brussels: European Commission.

Haworth R (2016). Personal learning environments: A solution for self-directed learners. Tech. Trends, 60(4):359-364.

Kühn C (2017). Are students ready to (re)-design their personal learning environment? The case of the e-dynamic. Space. J. New Approaches Educ. Res., 6(1):11-19.

Leone S (2013). Characterisation of a personal learning environment as a lifelong learning tool, New York: Springer.

Lim J, Newby TJ (2020). Pre-service teachers' Web 2.0 experiences and perceptions on Web 2.0 as a personal learning environment. J. Comput. High Educ., 32:234-260.

Mak TMW, Yu IKM, Wang L, Hsu SC, Tsang DCW, Li CN, Yeung TLY, Zhang R, Poon CS (2019). Extended theory of planned behaviour for promoting construction waste recycling in Hong Kong. Waste Manage. 83:161-170.

Nganji JT (2018). Towards learner-constructed e-learning environments for effective personal learning experiences. Behav. Inf. Technol., 37(7):647-657.

Saadatmand M, Kumpulainen K (2013). Content aggregation and knowledge sharing in a personal learning environment: Serendipity in open online networks. Int. J. Emerg. Technol. Learn., 8(1), 70-78.

Siemens G (2017). Connectivism. Foundations of learning and instructional design technology.

Tsang HWC, Tsui E (2017). Conceptual design and empirical study of a personal learning environment and network (PLE&N) to support peer-based social and lifelong learning. VINE J. Inf. Knowl. Manag. Syst., 47:228-249.

Tschofen C, Mackness J (2012). Connectivism and dimensions of individual experience. Int. Rev. Res. Open Dist. 13(1):124-143.

Tsui M, Tsui E, See-To EW (2013). Adoption of a personal learning environment & network (PLE&N) to support peer-based lifelong learning, In Proceedings of the Asian Conference on Society, Education and Technology.

Väljataga T, Laanpere M (2010). Learner control and personal learning environment: a challenge for instructional design. Interact. Learn. Environ. 18(3):277-291.

Van Harmelen M (2006). Personal learning environments. In Sixth International Conference on Advanced Learning Technologies, 815-816.

Valtonen T, Hacklin S, Dillon P, Vesisenaho M, Kukkonen J, Hietanen A (2012). Perspectives on personal learning environments held by vocational students. Comput. Educ., 58:732-739.