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Enhancing Collaborative Learning and E-Mentoring in a Smart Education System in Higher Education

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Abstract: The requirement to develop a smart education system is critical in the era of ubiquitous technology. In the smart education environment, intelligent pedagogies are constructed to take advantage of technological devices and foster learners' competencies which undoubtedly assist learners in dealing with knowledge and handling issues in a dynamic society more effectively and productively. This research suggests two effective learning strategies: (1) collaborative learning, which helps learners improve their knowledge and skills by exchanging resources and experiences, and (2) e-mentoring, which connects learners to a wide range of professional communities. This research first proposes a model to show how these two learning methods help learners achieve their goals, along with a set of hypotheses that are explained in detail. Then, a smart education system is proposed which comprises the two learning strategies with the necessary features. Lastly, two questionnaires, one for facilitators and the other for learners, are used to evaluate the usefulness and the feasibility of the proposed model in a real-world educational environment. The great majority of respondents agreed with all the statements, demonstrating the efficiency of the research for educators and learners.

Keywords: collaborative learning; e-mentoring; smart education; smart learning environment; smart learners; smart pedagogies

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1. Introduction

Technology has had a positive impact on most aspects of society, including education and learning [1,2]. The technological transformation of education has not only had an impact on learning materials and classroom boundaries, but it also offers learners various opportunities to acquire a range of skills and knowledge by connecting to a wide professional learning network [2,3]. Educators and learners are no longer limited by learning borders due to advances in technology, which has made online learning and hybrid learning possible, giving learners greater flexibility, a wide selection of courses, accessibility, and cost-effective options [4]. Online and hybrid learning also open the door to learning communities around the world, where learners can build a network and develop an international mindset [4].

In particular, in the era of the fourth industrial revolution, known as Industry 4.0, the development of digitalisation and the increasingly convergent boundaries between humans and machines are expected to produce a qualified and highly educated workforce [5,6]. Learners are required to acquire holistic competencies, including technical and non-technical skills that cannot be attained by learning from books and lectures alone [5]. Hence, designing

a smart education system is of critical importance to offer learners the opportunity to choose the learning pathway that is the most effective for them.

The smart education paradigm is one of the most effective and promising directions for educational development. The purpose of smart education is to cultivate a smart learner generation by immersing learners in intelligent pedagogies facilitated by smart environments with the support of technological advances [7]. There are three key factors contributing to a complete smart education system: smart learners, smart pedagogies, and smart environments. Smart learners not only possess sustainable hard skills, but also need to achieve the necessary soft skills, both in terms of personal skills (complex problem-solving, critical thinking, creativity, out-of-the-box thinking, emotional intelligence, and cognitive flexibility), and social skills (communication, teamwork, negotiation, and leadership skills) [8]. A smart environment and smart pedagogy support smart learners on their learning pathways. A smart environment is shaped by both software and hardware technological support, digital resources, and the contribution of smart pedagogies that are designed based on a learner-centric paradigm to shape learners who have different backgrounds, levels, and interests to enhance their necessary knowledge skills [7]. Consequently, two major pedagogical strategies, collaborative learning and e-mentoring, are designed to improve learners' knowledge, experience, and skills by not only encouraging them to actively communicate and exchange valuable learning resources but also helping them connect with professional communities.

Collaborative learning encourages learners to develop their capabilities by exchanging knowledge and experience with peers [9]. The paradigm provides learners with the opportunity to build a group themselves with common goals or to search for an existing group which has the same goals as the learner [10]. They engage in the learning process using a joint workspace where they can share resources, learn new concepts, and discuss and deal with uncertain theories and construct ideas together, especially in the case of learners in disparate locations [9]. Moreover, collaborative learning applications enable them to learn in both synchronous and asynchronous ways using a range of multimedia and devices [11]. Since collaboration takes place between learners with different backgrounds and characteristics and diverse fields of specialisation, learners can acquire new knowledge and cultivate advanced skills, such as intensive judgment and negotiation skills, wise emotional intelligence, and effective communication skills, contributing to building a stronger learning community [7].

Another effective learning strategy is to study with mentors who are experts in their field, with unique experiences and skills. E-mentoring takes place between mentors and mentees who desire to achieve mutual growth [12]. This approach consists of a matching mentor–mentee stage and learning process with flexible curriculums. By connecting with professional communities, learners are able to search for suitable mentors who can guide them, develop ideas, build knowledge, and encourage and assist them in their learning development [13]. Mentors with valuable experience, knowledge and skills can develop suitable programs and activities that can be flexibly adjusted as the learners progress. Hence, learners gradually acquire competencies to deal with complex problem-solving and decision-making.

In a smart education environment, both collaborative learning and e-mentoring are supported by technological advances that are breaking the barriers of learning space and time. A more immersive environment has been created with various dynamic media: virtual classrooms, a huge number of digital resources, and flexible tools and systems have been employed to improve collaboration. Subsequently, this paper focuses on "How effective is an integrated model that combines collaborative learning and e-mentoring in engaging learners with diverse backgrounds, characteristics, and interests?" and "How can technological advances be harnessed to enhance collaborative learning and e-mentoring strategies within a smart education context?".

This paper first discusses the importance of implementing two effective learning strategies, collaborative learning and e-mentoring, in the smart education environment.

Furthermore, it proposes a research model with a set of hypotheses to explain how these two learning modes engage learners so that they can achieve their goals effectively. Then, the implementation part presents a smart education system visually, focusing on collaborative learning and e-mentoring deployed in a higher education learning environment. This section proposes models with should-have features to provide a thorough understanding of how the system supports participants in teaching and learning, the way users interact with the system, and perform learning processes. Finally, this research illustrates the usefulness and feasibility of the framework in a real educational environment by evaluating the effectiveness of the functionalities from the perspective of the participants who are learning and teaching in a higher education environment.

2. Literature Review

To adapt to the changes and the requirements of the workforce in a digital and intelligent society, the key factors in the success of the new learner generation are classified into two categories: hard skills (analytical skills and research skills) and soft skills (critical thinking, problem-solving, decision-making, creativity, emotional intelligence, communication skills, teamwork skills, negotiation skills, ability to transfer knowledge, and leadership skills) [8]. Progressively, smart educational systems need to focus on creative, innovative, and communicative activities rather than routine activities with monitoring duties, which evolve and consider many promising trends, including opportunities to learn at diverse times and places, personalised learning based on students' capabilities, the use of technological advances and resources, the use of experiential and collaborative learning, student involvement in curriculum design, and increased mentoring approaches [14]. Zhu and He [7] proposed a research model in smart education with three essential elements: (1) smart learners; (2) smart environments; and (3) smart pedagogies (Figure 1), in which smart environments play a vital role in influencing smart pedagogies, and smart pedagogies are one of the key factors contributing to smart environments. The skills and knowledge enhancement of smart learners are supported by smart pedagogies and smart environments.

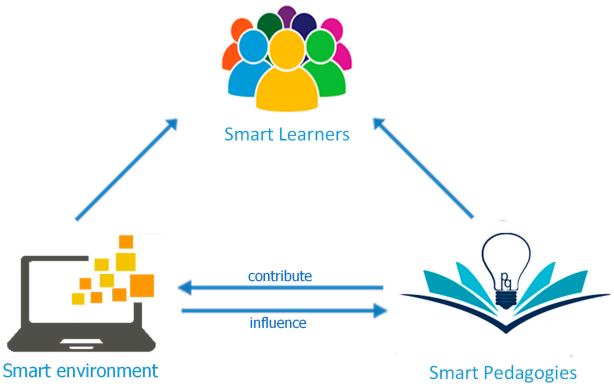


Figure 1. Smart education.

2.1. Smart Learners

Learners in a smart learning environment are demanded to learn smarter to acquire competencies to adapt to a modern and dynamic society. They are required to actively look for the knowledge and learning approaches that are appropriate for them [15] and build their own knowledge and skills by interacting with their peers, instructors, technological advancements, and learning resources [16]. Achieving success in a smart learning environment is difficult and depends heavily on learners' academic characteristics, such as collaboration, self-motivation, persistency, curiosity, and risk-taking, as well as the skills of time management, effective reading, creativity and innovation, and learning through co-operation [17]. Hence, to meet the needs of the smart education system, learners must master the following four skills [7]:

(1) Basic knowledge and core skills, which provide a foundation for skill development and setting future goals, and this is instrumental in the process of understanding concepts [18].
(2) Comprehension such as critical thinking and problem solving.
(3) Personalised expertise which challenges learners to think and suggest new ideas in studying and working to contribute to innovation.
(4) Collective intelligence refers to the abilities of a group of individuals to share and gather their knowledge and skills to perform tasks or deal with problems. This collective intelligence can be constructed by accumulating, arranging, and refining individual learning content followed by communication and collaboration between the learners [19].

2.2. Smart Pedagogies

Pedagogy is defined as a science that is constantly evolving and looking for a better way to teach and engage learners in the process of knowledge building. SMART stands for Self-Monitoring Analysis and Reporting Technology. In the contemporary society, wherein technology is integrated into education, smart refers to smart devices [20]. Zhu et al. [7] argue that, if the goal of the educational process is learners, then, for smart pedagogies, which focus on smart learners, technology is a supporting factor influencing the learning environment. A dynamic and intelligent society requires the future workforce to possess holistic competencies, such as strong logical thinking and decision-making, judgment and negotiation skills, organisational leadership and management qualities, and interpersonal and high-level communication skills, which are fostered by practice and problem-based learning approaches. Learners should be experienced in applying effective learning strategies, namely, having the ability to actively use theoretical knowledge in practice, engage in open discussion, understand problems from different perspectives, and learn from more experienced people; moreover, within interdisciplinary groups, with teamwork and practice, develop the soft skills needed for cooperation and communication in solving common tasks. Furthermore, each individual learner with a different background, education level, and interest deserves suitable and flexible curriculums which ignite their passion and promote their understanding [21]. Hence, learning collaboratively and mentoring are the two most important learning strategies that provide opportunities for learners to broaden their views and gain comprehensive knowledge.

2.2.1. Collaborative Learning

In a smart learning environment, facilitators are required to design their teaching strategies flexibly, enhance the quality of the teaching content, and evaluate the impact of the learning process on students' outcomes [22] to motivate learners to study actively. Therefore, collaborative learning has become one of the most effective pedagogical approaches in the design of a smart learning environment. Knowledge acquired from lectures is a key fundamental of core knowledge and the basic skills required for learners in their learning pathway. However, in higher education, to develop core knowledge, enhance advanced comprehension abilities, and, especially, engage in flexible problem-solving, learners need to step out of their comfort zones by actively exchanging knowledge and skills and studying with their peers.

As shown in Figure 2, collaborative learning is an educational strategy where learners are encouraged to study and work in a group to perform tasks together and achieve common goals. Karin et al. [9] stated that this kind of study provides an opportunity for learners to develop both cognitive skills, such as analytical skills, research skills, critical thinking, problem-solving, and decision-making, and pro-social behaviour, like understanding, communicating, negotiating, helping, sharing, and cooperating. Moreover, learners who study in a group achieve a significantly better understanding in comparison with those who study individually. In the group learning context, learners engage in high-quality social interaction, such as discussing contradictory information, explaining and questioning one another

critically, recognizing misconceptions, and strengthening the connections between new information and previously learned knowledge. Additionally, it is an advisable strategy that helps facilitators recognize a poor-performing student and help them find a solution to improve their learning performance and engagement.

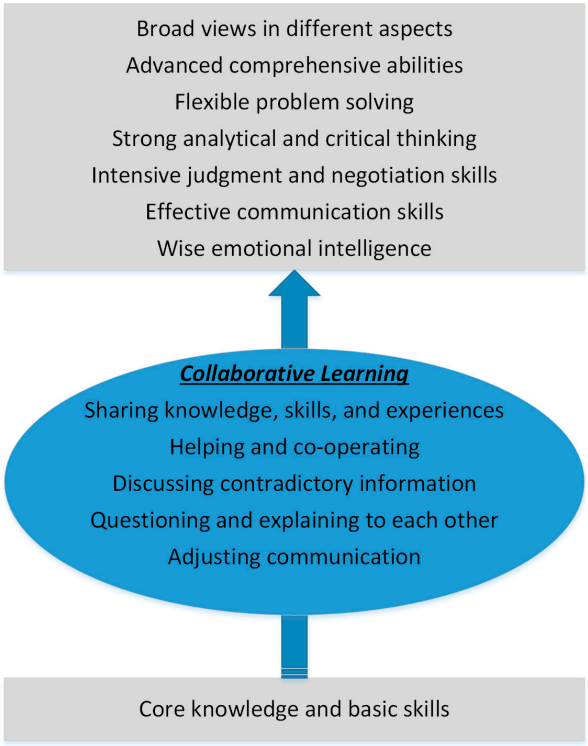


Figure 2. Collaborative learning enhances knowledge and skills.

2.2.2. E-Mentoring

Mentoring is mostly conceptualised as a learning process where the experienced mentor provides guidance, instruction, encouragement, role modelling, and emotional support to a younger person [23]. Mentoring is also defined as a collaborative learning and mutually beneficial relationship where both mentors and mentees foster their personal and professional development by engaging in professional activities [12]. In higher education, the role of mentors is critical because they direct mentees on the path to success, enhance their academic achievements, reduce their stress, and inspire them to engage in a cycle of learning [3]. There are many types of mentoring relationships, such as traditional mentoring, peer mentoring, group mentoring, reserve mentoring, and situation mentoring, which depend on many factors, such as the purpose and goal of learning, the organisation's circumstances, willingness, availability, and appropriateness according to the individual's situations, as well as the length of the learning time [24]. The key factor to success in an e-mentoring program is the establishment of a strong personal relationship based on trust, self-motivation, flexibility, communication skills, and technological skills. Two important elements need to be considered: (1) matching appropriate mentors and mentees [25] and (2) building a strong relationship between mentors and mentees [26].

E-mentoring is a process where a virtual platform is used to facilitate mentoring relationships. Participants not only engage in synchronous and asynchronous online dialogue through various aspects of the course but can also be introduced to social and professional networks, providing a valuable opportunity to connect to a pool of mentors and mentees [26]. However, Colky and Young [27] suggested that understanding the mentoring process established in a traditional learning environment is necessary for effective mentoring in a virtual environment. There are four phases to a mentoring relationship: (1) initiation, which involves identifying and matching mentors-mentees; (2) training,

where the success of a mentoring program is dependent on the training given to both the mentors and mentees and aims to familiarise all the partners with the techniques and the overall goals of the mentoring program; (3) monitoring, to assess if the mentoring process is working well or if there is a need for retraining; (4) evaluation, which involves evaluating the mentoring results and obtaining recommendations to improve the first three steps [28].

2.3. Smart Learning Environment

Huang et al. [29] pointed out that the objective of a smart learning environment is to promote easy learning, engaged learning, and effective learning. Consequently, it is necessary to design a smart learning environment technically and pedagogically. It should be expanded in space, time, technology, interaction, and control [8] to facilitate and engage learners to experience a seamless learning process and perform tasks in an easy and natural way. Technology covers both hardware and software. Hardware includes tangible technological devices such as IQ boards, projection screens, interactive LCD/LED touchscreens using cloud computing, ubiquitous computing, IoT technology, and smart audio–visual systems. Software includes learning tools, online resources, new supporting applications using virtual reality technology, and learning analytics. From a pedagogical perspective, a learning environment is implemented to assist facilitators in designing and conducting lessons and learning activities effectively and supports learners to enhance their knowledge and skills with the additional flexibility and diversity of the learning practice [6].

Many researchers have found that a smart learning environment has considerably changed the way learners and facilitators interact with each other, enabling collaboration in a flexible environment [10,30–32]. Learning processes are maintained from building groups to monitoring students' progress and adjusting curriculums accordingly to suit the student's needs. A smart learning environment supports learners to form the right group by finding suitable partners in a wide range of learning communities. Learners receive opportunities to experience virtual learning environments where they can study both asynchronously and synchronously, have access to shared repositories with diverse valuable resources, and join in common learning workspaces. The learning progress is monitored and evaluated to identify the strengths and weaknesses of the learners and the curriculum for improvement (as shown in Figure 3).

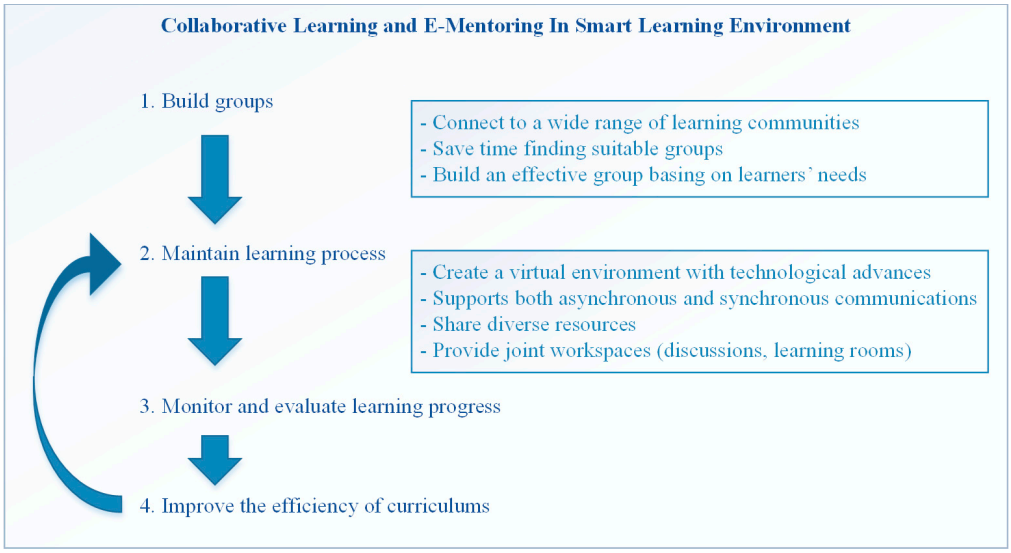


Figure 3. Collaborative learning and e-mentoring in a smart learning environment.

Smart education is becoming a promising trend to ensure the development of a new generation of the smart workforce who need to be equipped with valuable competencies, involving sustainable knowledge and flexible skills. Smart pedagogies are designed to

focus more on learners, influencing a learning environment that is supported by technology and intelligent devices to be flexible, diverse, and smart [7]. As a result, two learning approaches, collaborative learning and e-mentoring, are considered as effective learning strategies for learners to adapt to future requirements. To further explain the theory, the next section proposed a model to show how collaborative learning and e-mentoring help learners reach their goals effectively in a smart education environment.

3. Research Model

Learners are expected to study within a collaborative environment, sharing their knowledge and skills to enhance their performance in critical thinking and improve their problem-solving skills [7]. The knowledge imparted and the lessons delivered by experts and experienced facilitators are necessary for learners to gradually advance their careers [29]. It is clear that collaborative learning and e-mentoring are the two most efficient approaches to smart pedagogies, in which learners and facilitators exchange knowledge productively to achieve their ongoing learning goals. The exchange of knowledge is a dynamic and social process that incorporates various forms of knowledge from multiple sources [33]. The process is achieved through peer interaction and diverse resource sharing. Additionally, in e-mentoring, learners have opportunities to interact with professional communities, wherein they can find not only facilitators, instructors, and professors in their institutions but also experts in the specific fields that they require. Learners are also engaged in flexible curriculums, which are adjusted to suitably enhance their improvements. Mentors share wisdom, experience, deep knowledge, and also their successes and failures [23] to help mentees achieve their goals and objectives [34], connect knowledge to handle situations logically, and build new knowledge with the aim of succeeding in their learning pathway [35] (as shown in Figure 4).

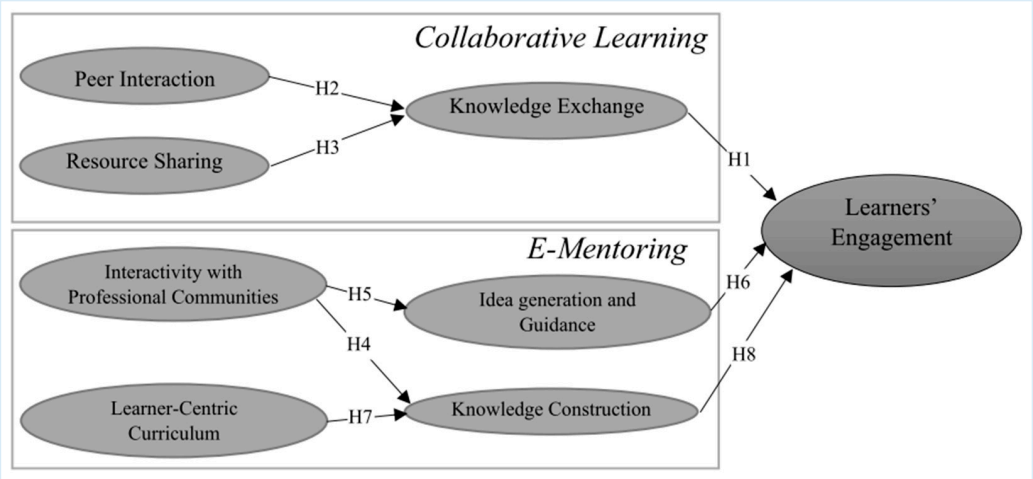


Figure 4. Proposed research model.

Core knowledge and basic skills from books and lessons are key fundamentals that help learners develop other advanced skills. However, cognitive skills, such as analytical skills, research skills, critical thinking, problem-solving, and decision-making, as well as pro-social behaviour, like understanding, communicating, negotiating, helping, sharing, and co-operating, cannot be attained by self-learning but by engaging in high-quality social interaction, in which knowledge is exchanged actively, contradictory information is discussed and explained critically, and misconceptions are identified and handled effectively, so that new information and previously learned knowledge will be connected strongly [9]. Chi et al. [11] stated that actively engaging in an exchange with peers, such as watching a tutorial video or solving a problem together using each other's knowledge and experience, helps learners construct an in-depth understanding and enhance their knowledge in a way that is similar to directly receiving the guidance from a highly experienced instructor. In

addition, Pangil [36] pointed out that knowledge grows when it is shared and used but depreciates in value when being kept to oneself. Sharing knowledge can stimulate learners' creativity by generating new knowledge. Consequently, learners have a greater opportunity to acquire the necessary skills and achieve their goals when learning collaboratively.

Therefore, we hypothesise:

H1: *Active knowledge sharing in collaborative learning effectively improves learners' engagement.*

Individuals often possess distinctive experience and expertise that should be combined, especially, to complete tasks that require the combination of different knowledge bases [10]. A smart education environment that incorporates technological advances assists learners at right the first stage, which is to form a suitable group. By using the intelligent features of a learning system, learners input their requirements as they want to find the best match partners or facilitators; then, the system should sort out collaborators with appropriate criteria based on their expertise and background [10]. This stage is the key factor in all collaborations because partners who are appropriately matched not only exchange their new knowledge and perspectives but also provide constructive feedback and motivational encouragement to each other [22], especially in relation to peer-reviewed works.

Additionally, along with learning processes, learning applications with ubiquitous mediums support participants in experiencing new ways of learning, which facilitates their constant interactions, regardless of the distance. Since then, learners have more opportunities to understand each other and deal with tasks effectively. Learners need a space in which they are assisted to continually discuss, refer to others' ideas, develop solutions together, keep track of prior discussions, and create a synergy of individual contributions [37]. Hence, the following hypothesis is proposed:

H2: *A learning environment that facilitates peer interaction will positively affect knowledge sharing.*

Collaboration refers to a situation where participants share their resources, knowledge, and experience with others. This exchange process can be performed directly or indirectly via a knowledge repository, where members provide and access each other's knowledge resources such as data, information, and knowledge [38]. In shared repositories, partners can easily exchange and organize diverse resources regardless of their location [10]. Furthermore, learners would like to study in a dynamic learning environment with the support of technological advances to assist them in both synchronous and asynchronous communications, in which they are given opportunities to understand new concepts or phenomena more visually, which can foster their in-depth knowledge to engage in real-world problem-solving [31]. Knowledge resource sharing saves time and energy for all partners and helps them explore problems and solutions more deeply through shared ideas from others. Hence, we propose the following hypothesis:

H3: *A learning environment that facilitates resource sharing will positively affect knowledge sharing.*

Knowledge is not static, it exists and is codified through collaborative processes [39]. According to Kaplan [40], nearly 70% of the knowledge that an employee needs to be successful is cultivated outside of formal training. Forming a community connection is one way to create and structure opportunities where learners interact, capture, formalize, and disseminate implicit knowledge. Additionally, knowledge productivity appears not to be an inborn capability, but, rather, is accumulated by professional knowledge building [41] that produces a deeper understanding in more complicated domains than knowledge exchange [42]. Being a professional involves producing solutions for actions and building knowledge progressively using a knowledge base; however, knowledge and action seem to be distinct or disconnected. Communication with professionals who grasp the nature of knowledge and who have a view on how it will be acquired and organized in the mentoring

process is the way to unfold knowledge and collaboratively build knowledgeable action in practice situations [41]. Consequently, the following hypothesis is proposed:

H4: *A learning environment that facilitates sufficient interactivity with professional communities positively affects knowledge construction.*

In a broad professional community, knowledge, experience, and wisdom from older and more experienced professionals are valuable sources of learning that cannot be ignored. Mentoring is an efficient learning strategy used in higher education environments to enable learners to connect to a pool of intellectual knowledge and to take advantage of these valuable resources [3]. Mentors have more experience and should guide the mentee with patience, positivity, and openness to provide help, instruction, encouragement, role modelling, and emotional support [23].

Depending on many criteria, such as the learning goals, the organisational factors (culture, structure, strategies, or policies), or individual situations, mentoring occurs in different forms of learning, namely, traditional mentoring, peer mentoring, group mentoring, reverse mentoring, or situation mentoring [24]. Regardless of any type of learning, the success of a mentoring process is measured based on the satisfaction of both partners and their achievements. These outcomes depend on the establishment of a solid relationship between mentors and mentees, which is built by matching the right mentor with the right mentee, and needs to be maintained along the learning pathway [26]. It is not intended that a mentor provides solutions to various problems, but that they actively listen to ascertain the learners' interests and needs, determine the goals together, and build trust. After this, the mentor assists the learners in finding resources, imparting knowledge, explaining, discussing, and developing ideas, sharing experiences and mistakes, observing learning processes, providing constructive feedback, and also encouraging and inspiring learners to reach their goals [43]. Hence, the following hypothesis is proposed:

H5: *A learning environment that facilitates sufficient interactivity with professional communities positively affects idea generation and guidance.*

For a successful mentoring process, establishing the goals to pursue may be especially important and should be a collaborative progress. Depending on the learners' knowledge base, experience, and improvement throughout the mentoring relationship, partners need to keep the learning progress on track, as well as clarify and constantly reconsider the learning goals to achieve a satisfactory outcome [34]. The consentaneous target results in a higher quality mentor–mentee relationship and a greater sense of attainment [44]. By receiving support and guidance from facilitators, learners can be oriented to smarter goals, be inspired in the cycle of learning, and be guided to stay on the right track to success. Moreover, they not only receive valuable knowledge and experience, but they also acquire skills, gain mastery, and develop maturity [24].

Thus, this paper proposes the following hypothesis:

H6: *Idea generation and guidance in e-mentoring effectively improve learners' engagement.*

A learner-centric approach, which is referred to as the outcome-based approach or what the learner is expected to achieve at the end of the learning period, has become an international trend in education [45]. Moreover, "smart" in a smart learning environment refers to the flexibility and adaptability framing the learners' targets [7]. This means pedagogies can be adjusted suitably depending on the learners' progress, which needs to be monitored and evaluated regularly. These processes are complex, difficult to perform, and take much time and effort. However, partners who immerse themselves in a smart learning environment should be assisted in monitoring their learning progress, such as recognizing how much work the learners have done or knowing about peers' contributions, which can prompt learners to adjust their behaviours or give ideas to mentors in relation to modifying

the curriculum [46]. In doing so, the mentor will understand a learner's perceived capacity and how they interpret knowledge; hence, the learner will be guided to correct any misconceptions and will accumulate knowledge and experience for new understandings and interpretations [47]. Thus, this paper proposes the following hypothesis:

H7: *A learning environment that facilitates a learner-centric curriculum improves knowledge construction.*

Knowledge construction in higher education is important because it ensures that students are experiencing meaningful learning [48]. People may often understand and interpret the same things in different ways [49,50]. The ability to exchange information, develop arguments and justifications, and make decisions are attributes that help learners become critical thinkers with the ability to construct knowledge at high levels [48]. In the mentoring process, a facilitator's role, wisdom, experience, and ability help to link knowledge into a structure to guide, support, and direct students as they advance their understanding of learning. Thereby, the location of the knowledge base is shifted from the "outsider", or expert perspectives, to "insider" perspectives [51]. In this way, learners achieve rich and coherent knowledge structures, which appear as a deeper understanding of a field and an easier activation of new knowledge [35]. Hence, the following hypothesis is proposed:

H8: *Knowledge construction in e-mentoring effectively improves learners' engagement.*

The research model focuses on the principal ideas of collaborative learning and e-mentoring, which provide learners with various opportunities to immerse themselves in a broad professional learning environment. Knowledge, experience, and skills are accumulated naturally via active and flexible pedagogies. Along with research theory, this paper also concentrates on developing these efficient pedagogies in a smart education environment, supported by advanced technologies in which learning activities are logically organized to engage learners in an efficient learning pathway. As a proof of concept, the model is implemented as a web application to provide a clear and practical method that allows a multifaced concept to be explained visually and easily.

4. Implementation

In this section, the model is visualized as a web application to demonstrate the effectiveness and flexibility of two smart pedagogies, collaborative learning and e-mentoring. The application is built using the PHP programming language with the My SQL database for reliability and flexibility. The user interfaces are designed using a front-end framework, Bootstrap, to create a dynamic, consistent, and responsive web application. The application dashboards are classified into two sessions based on the two types of users involved in the learning process, namely, learners and teachers. This framework is designed to be governed by the admin, who assigns appropriate rights to certain users. All the users have the same rights to access collaborative learning functions, just different ones between team leaders and members. However, mentors and mentees are responsible for specific tasks, as mentors manage all learning activities and mentees have permission to conduct activities that mentors assign to them.

As shown in Figure 4, the different components contributing to collaborative learning and e-mentoring help learners succeed in their learning pathways. However, collaborative learning and e-mentoring take place in separate processes. The following sections explain each component that is integrated into the learning process in more detail to raise awareness of the way to conduct learning activities effectively and provide an in-depth understanding of the proposed model in this research.

4.1. Collaborative Learning

Collaborative learning occurs when a group of students or a group of teachers are guided by a facilitator to solve a problem, carry out a task, or learn a new concept. Goal achievement is driven by exchanging knowledge and experience (as addressed in H1), in which peer interaction and resource-sharing activities are key aspects supporting learners in the learning process (H2 and H3). As stated in H2 and H3, the implementation should involve the design of a learning environment that assists learners to work in a productive group wherein they maintain positive communication and share resources effectively.

However, not all groups foster effective collaboration because of the differing cognitive, social, emotional, and academic status of the participants [22], resulting in a lack of collaborative skills, free-riding behaviour, or unequal participation [19]. Therefore, it is important to build the right group at the beginning of the process because an effective group strengthens collaboration and avoids internal competition. As shown in Figure 5, the application offers users two flexible choices to join the most suitable group, namely, (1) sending a request to an existing group and becoming a member after the request is accepted or (2) being added to a new group. Collaboration activities occur after the group has been formed successfully and are completed when the common goal has been achieved.

Figure 5. Collaborative learning process.

The application is designed to help members engage in the learning process with multiple detailed activities. Firstly, they can engage in peer interactions (addressed in H2) in a joint workspace asynchronously with discussion boards to handle issues and keep track of each other's contributions to achieve a common goal or synchronously with video conferences and appointments. Moreover, they can easily share diverse resources and access those of others using a shared repository (H3). Peer review is a specific collaboration activity where users assist peers to improve the overall quality of their academic work. Figure 5 illustrates the collaborative learning process.

As shown in Figure 6 above, a user can successfully perform collaborative learning processes from building a group to completing their group's activities. A user can join an existing group by selecting "Search Groups" and sending requests that are managed in "Manage Group Requests". Moreover, a user can create a new group and send requests to other users asking if they want to participate. The "Manage My Requests" function manages all the requests sent directly to the user, which the user can choose to join the group or decline. A member of a group has permission to conduct all learning activities via "Manage Group detail", "Peer Reviews", and learning synchronously with appointments. To clarify H1, H2, and H3, this section visualizes several specific processes using user interfaces, in particular, (1) joining an existing group by making a request, (2) creating a new group, and (3) peer reviewing.

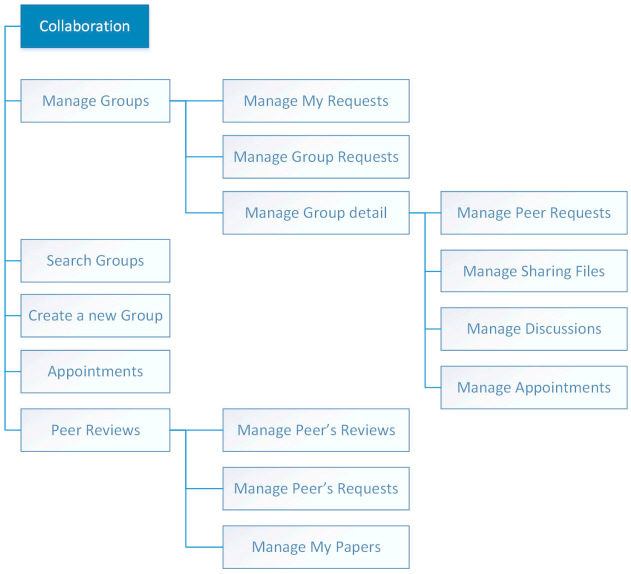


Figure 6. Functional organization of collaborative learning.

4.1.1. Join an Existing Group by Making a Request

In cases where a user wants to participate in an existing group, the application should support the user easily using the following steps: (1) searching groups with several criteria, as shown in Figure 7, (2) sending a request directly to a group or viewing the detail of a group and then sending a request, and (3) waiting for the approval, as it can be accepted or declined.

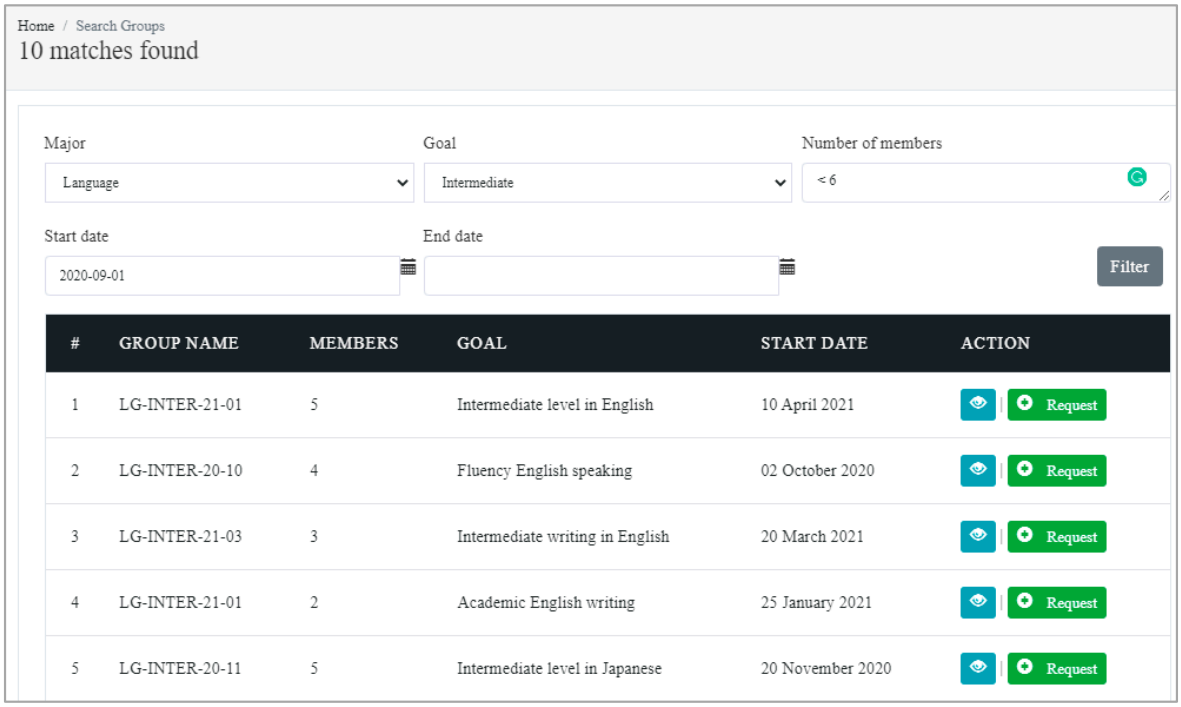


Figure 7. Search groups.

Requests to join a group are displayed when members open the group's details (Figure 8). Members can view the details of the request (Figure 9); however, only the team leader has the right to accept or decline requests. After being accepted, the user becomes a member of the group. Otherwise, the declined requests are sent back to the user with suitable reasons.

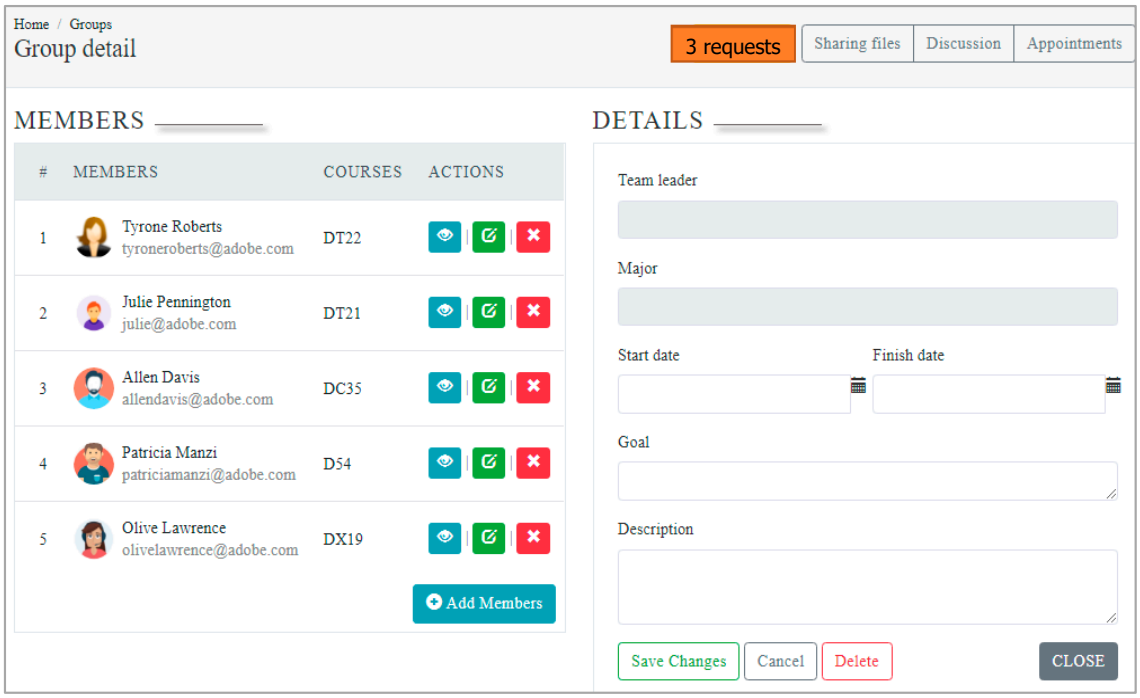


Figure 8. Details of the group.

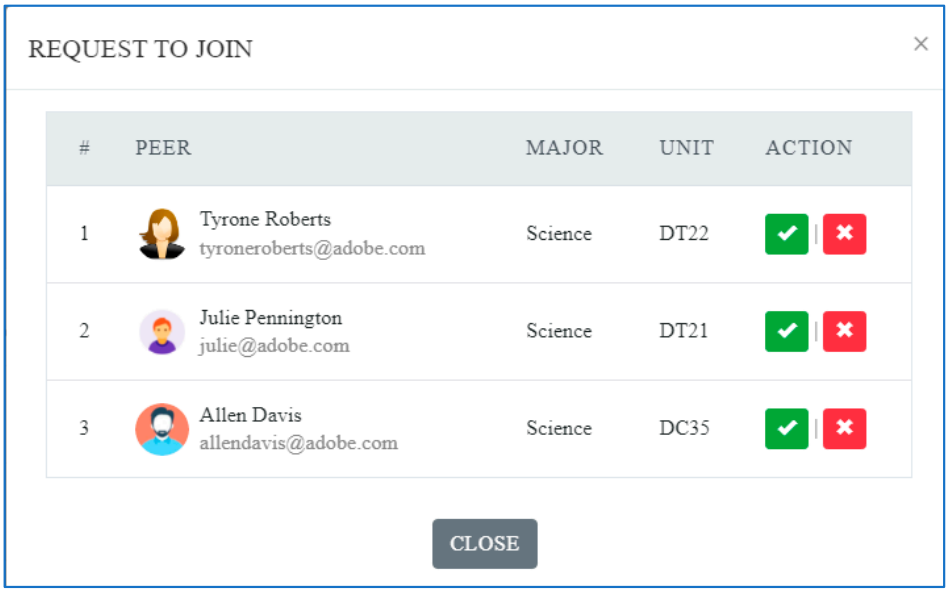


Figure 9. Details of the requests.

4.1.2. Create a New Group

At the beginning of a learning process, a new group is usually created with detailed information (major, learning's goal, start day of learning, description). The creator of the group will add new members by searching for peers and sending requests to ask members to join the group. As shown in Figure 10, a new group is built using the following steps: (1) inputting and saving the details of the group, (2) searching for peers using specific criteria, and (3) sending requests to learners asking them to join the group.

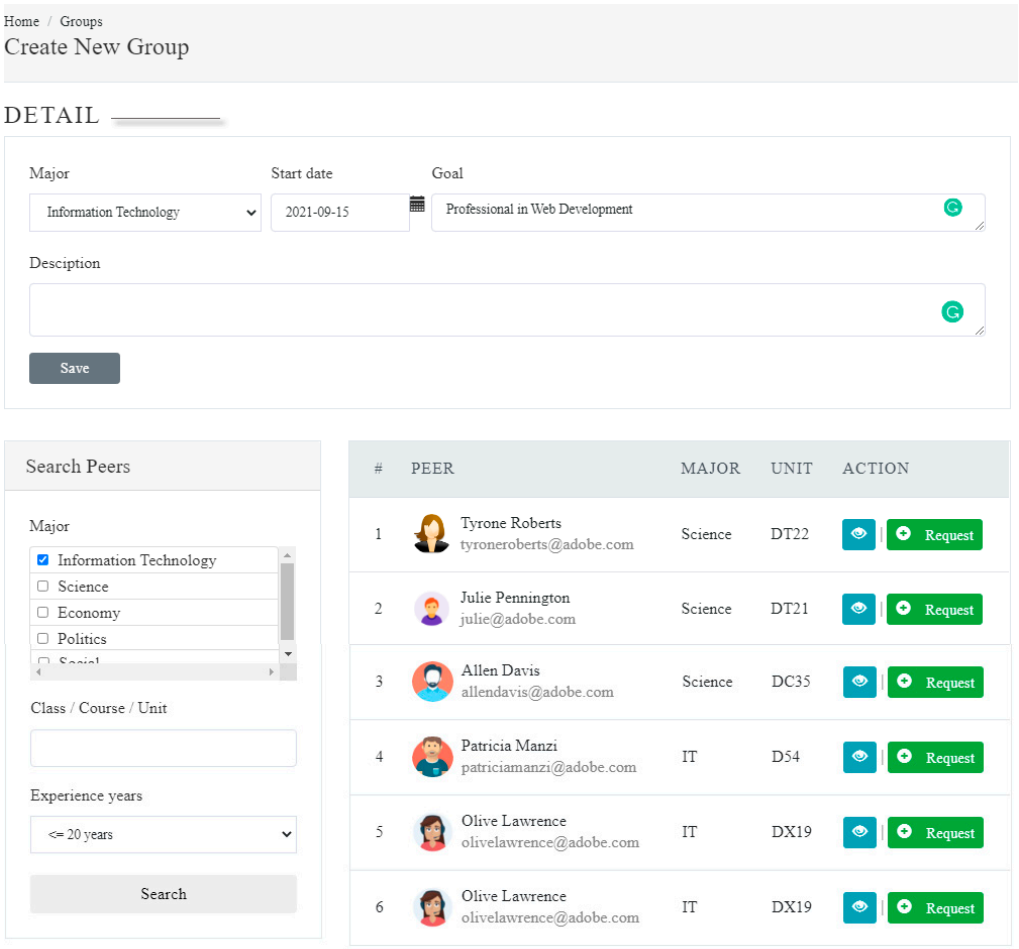


Figure 10. Create a new group.

All the requests to join a group are sent directly to the user with the group list (Figures 11 and 12). The user views the detailed information and chooses to join the group or decline with their reasons.

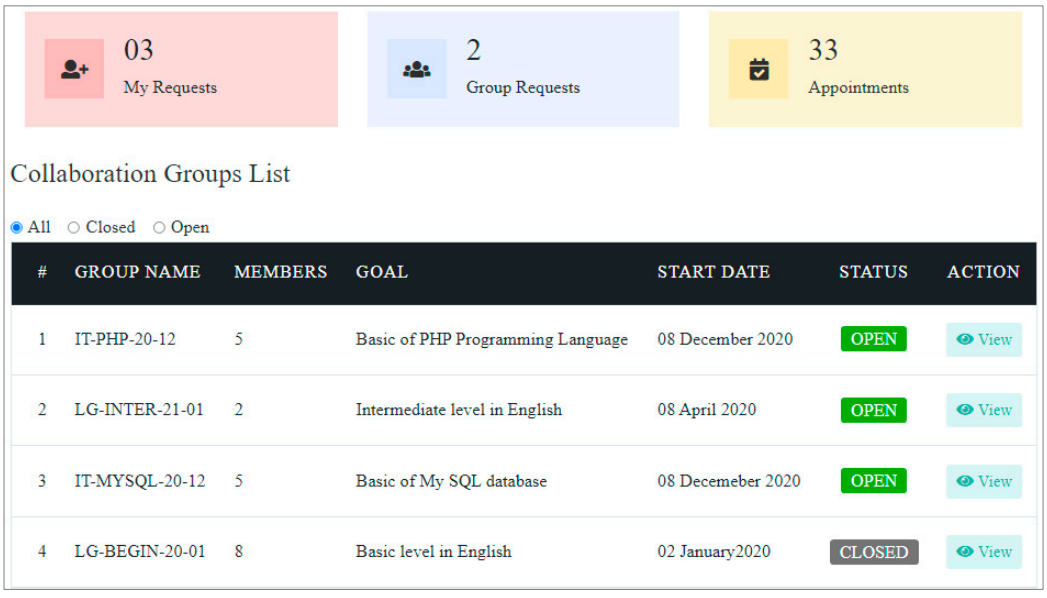


Figure 11. Group list.

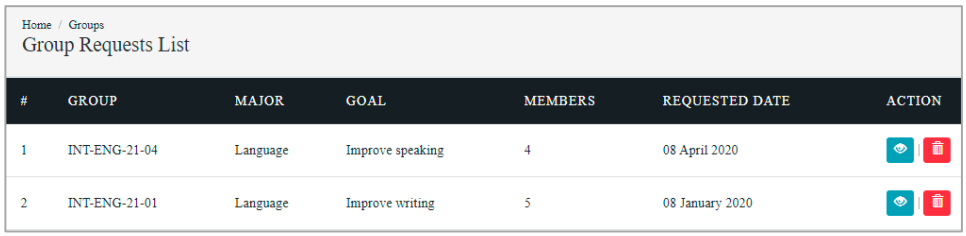


Figure 12. Group requests.

After becoming a member of a group, users engage in learning activities directly using the group's detail interface (see Figure 8). Learners have the opportunity to share resources with each other and participate in interactions by joining discussions and meetings.

4.1.3. Peer Review

Peer review is a specific kind of collaboration, with the objective of improving the overall quality of an academic task. Figure 13 shows the details of a review work. After receiving and accepting a request to be a reviewer, the user undertakes the process by viewing the details of a peer's work, downloading the paper, and leaving comments or uploading the reviewed file.

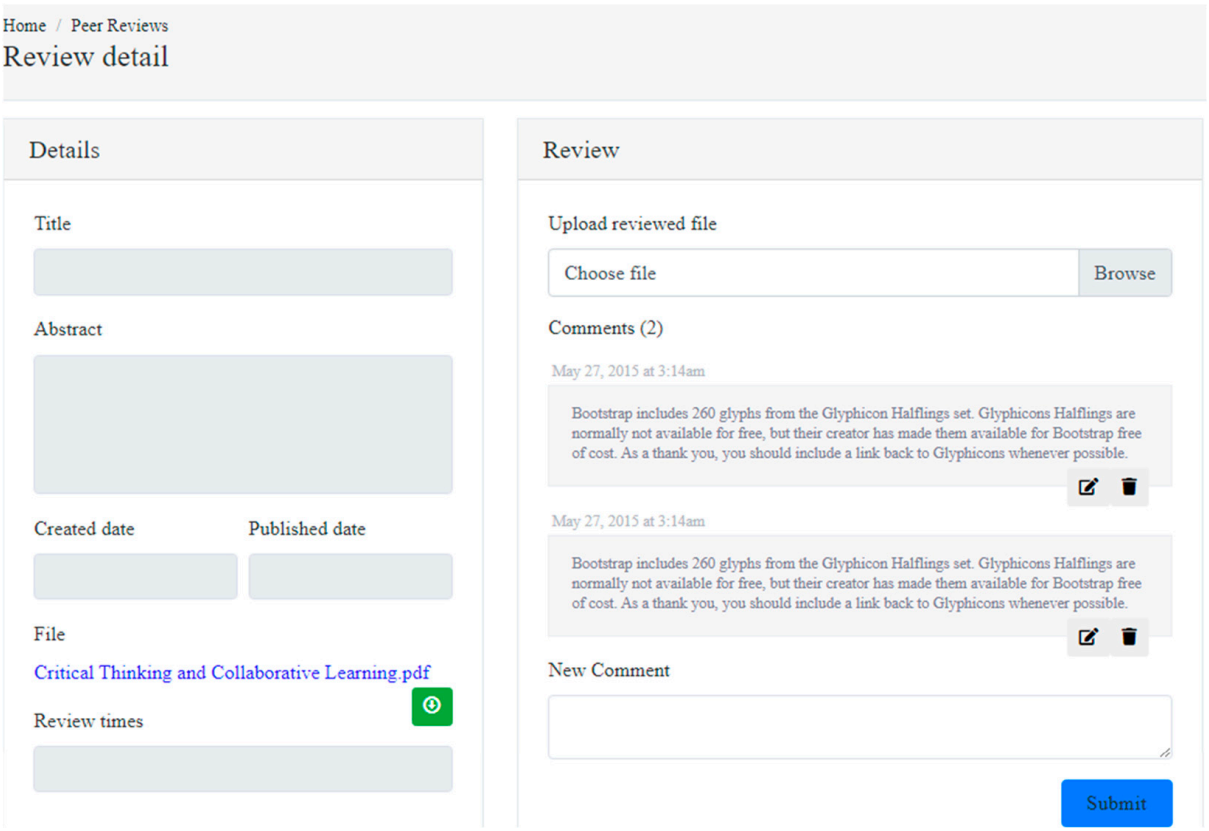


Figure 13. Reviewed peer paper.

The authors are able to easily follow all the reviews by viewing the details (Figure 14). After each review, the author can upload the most recent file and send another review request. This process is conducted iteratively until all the work has been accepted and the paper is published.

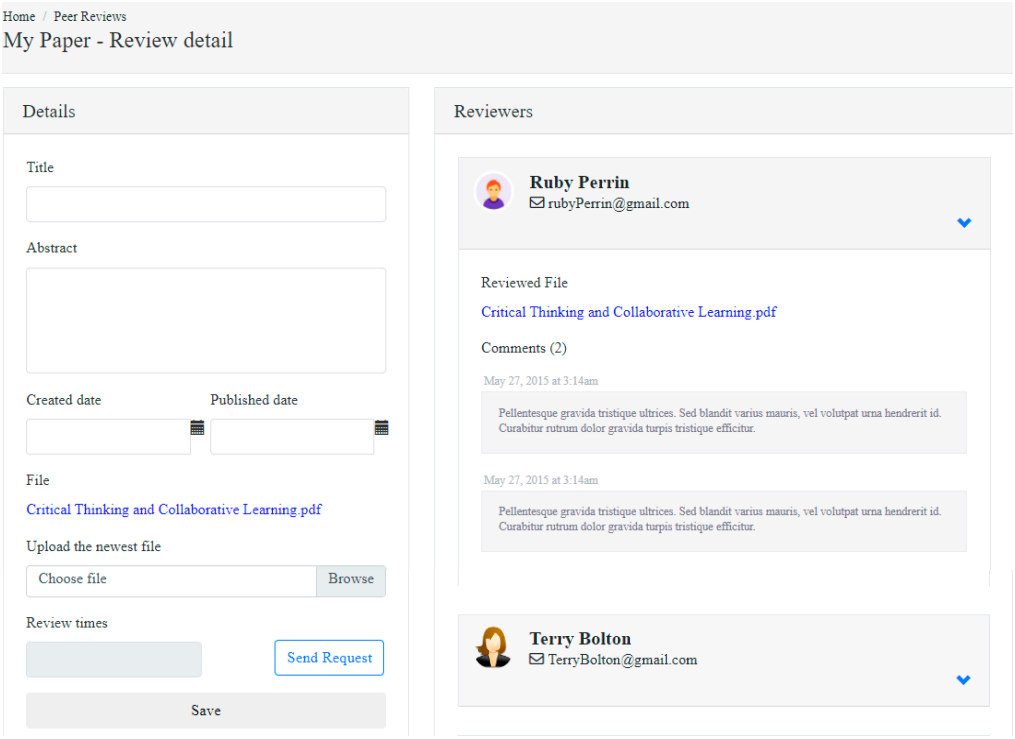


Figure 14. View review detail.

4.2. E-Mentoring

As shown in Figure 4, interactivity with professional communities (addressed in H4 and H5) and learner-centric curriculums (H7) are two core features contributing to the success of the mentoring process. Therefore, by being immersed in e-mentoring, learners should be supported to engage in a learning environment that facilitates a broad connection with professional communities and flexible learner-centric curriculums.

A mentoring and learning process begins after mentors and mentees have been matched successfully. Mentees engage in learning activities, such as conducting lessons and assessments and joining in online classes and discussions. During a learning process, mentors monitor the improvement of mentees and then adjust curriculums to be more effective for learners, focusing on the learners' goals. By that, the implementation logicizes mentoring processes as the model below (Figure 15)

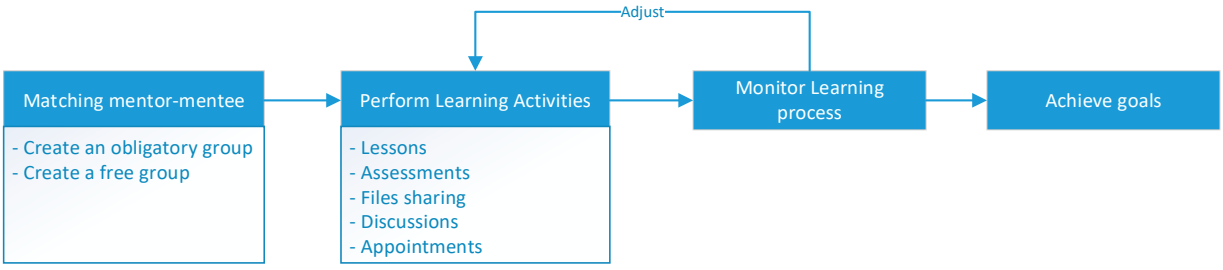


Figure 15. E-mentoring process.

When engaging in the e-mentoring process, although mentors and mentees carry out some tasks similarly in comparison with collaborative learning, the responsibilities of mentors and mentees are disparate. As shown in Figure 16, a mentor who can be a facilitator, an instructor, or a supervisor has a right to create a group of mentees by performing the "Match Mentoring Group" function. The mentor organizes learning activities by managing mentoring details, setting up appointments, and adjusting lessons and assignments accord-

ing to learners' progress. Another way for a mentee to participate in a mentoring process is to search for a mentor who is suitable for the mentee's requirements and send requests, which are managed in "Manage My Requests" (as shown in Figure 17). These requests can be accepted or declined by the mentor using the "Manage Mentoring Requests" function (Figure 16). The mentee completes learning activities in "View Mentoring detail" and tracks the results of completed lessons and assignments in "View Learning progress" (Figure 17).

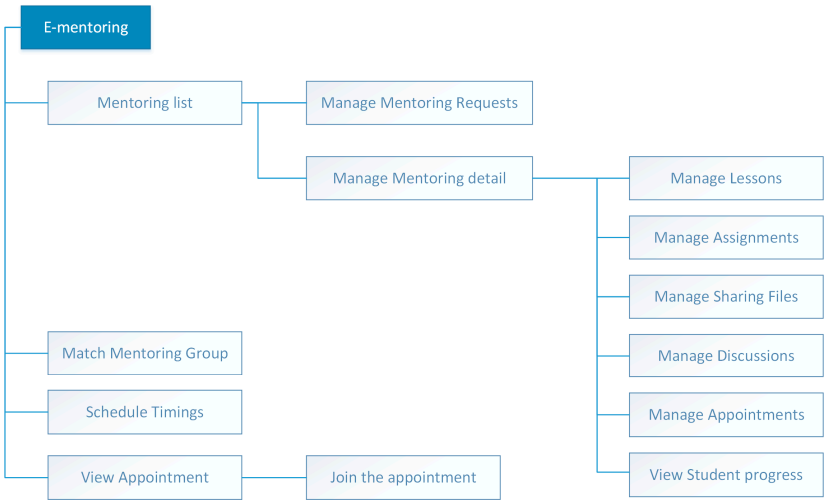


Figure 16. Functional organization of e-mentoring for mentors.

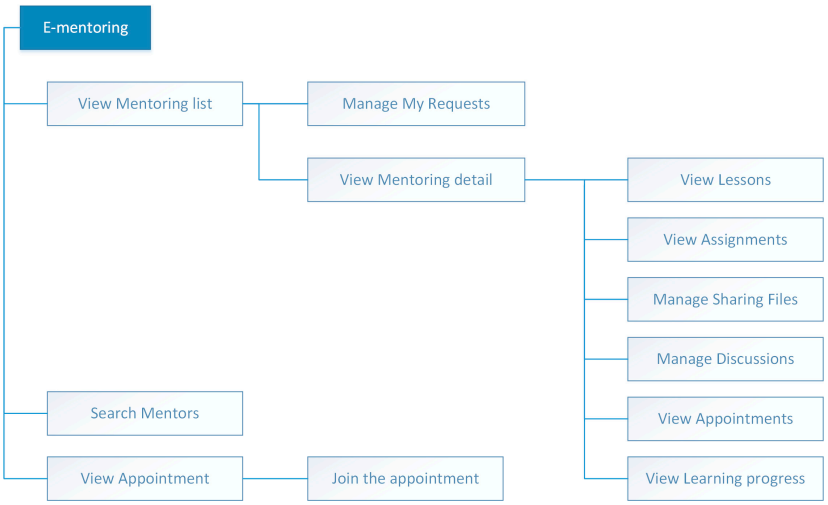


Figure 17. Functional organization of e-mentoring for mentees.

This section explains the process of matching a mentor with a mentee, which is the first and most important process in ensuring the effectiveness of the interactions between the mentor and the mentee (H4 and H5). Moreover, this section clarifies the adjustment of learner-centric curriculums in H7 using the monitor-learning process interface.

4.2.1. Matching Mentor–Mentee

Ragins and Kram [13] proposed that an initial match has a significant effect on the relationship between mentors and mentees and the e-mentoring process. Approximately 95% of participating mentors and mentees are satisfied with mentoring processes if they are able to search for the most suitable matches. Hence, to help learners interact effectively with a wide range of professional communities, the application should offer users the chance to look closely at the online matching system, in which both mentors and mentees complete their profiles with their interests and preferences. Suggestions based on com-

mon preferences, such as majors, interests, and research fields are given. Then, using a sophisticated computer algorithm, the system presents some potential matches and gives the mentee the opportunity to select the most suitable one.

The tasks of matching appropriate mentors and mentees should be based on trust and flexibility. Based on the different types of mentoring, such as traditional mentoring, peer mentoring, group mentoring, or situation mentoring, the application supports the matching process in two ways, namely, (1) creating an obligatory mentoring group and (2) creating a free mentoring group.

4.2.2. Creating an Obligatory Mentoring Group

An obligatory mentoring group is a group that requires participants to join the mentoring process. Only mentors have permission to create a matching, as illustrated in Figure 18. Mentors and mentees are added to the mentoring group by being searched according to the criteria or directly by name. With the input information, the group is created, and the mentoring process has begun.

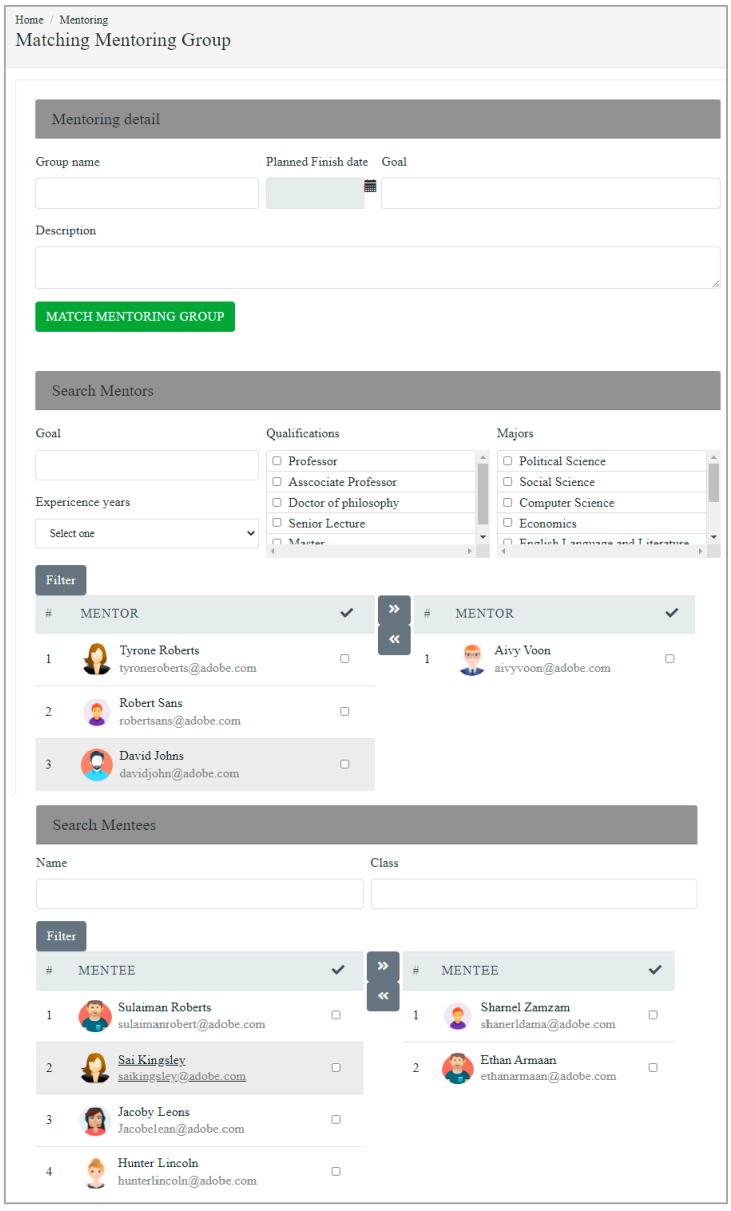


Figure 18. The process of matching mentors and mentees.

4.2.3. Creating a Free Mentoring Group

The matching process in a free mentoring group is performed by the learners. If learners want to be mentored in relation to a particular skill or if they want to learn a new concept, they can easily search for mentors by inputting specific criteria, such as the skills the learners want to improve and the requirements the mentors must possess. Then, the learners choose an appropriate mentor and send a request (Figure 19). However, the mentoring process starts when the mentor accepts the request. Otherwise, the learners continue with the matching process to find a suitable mentor.

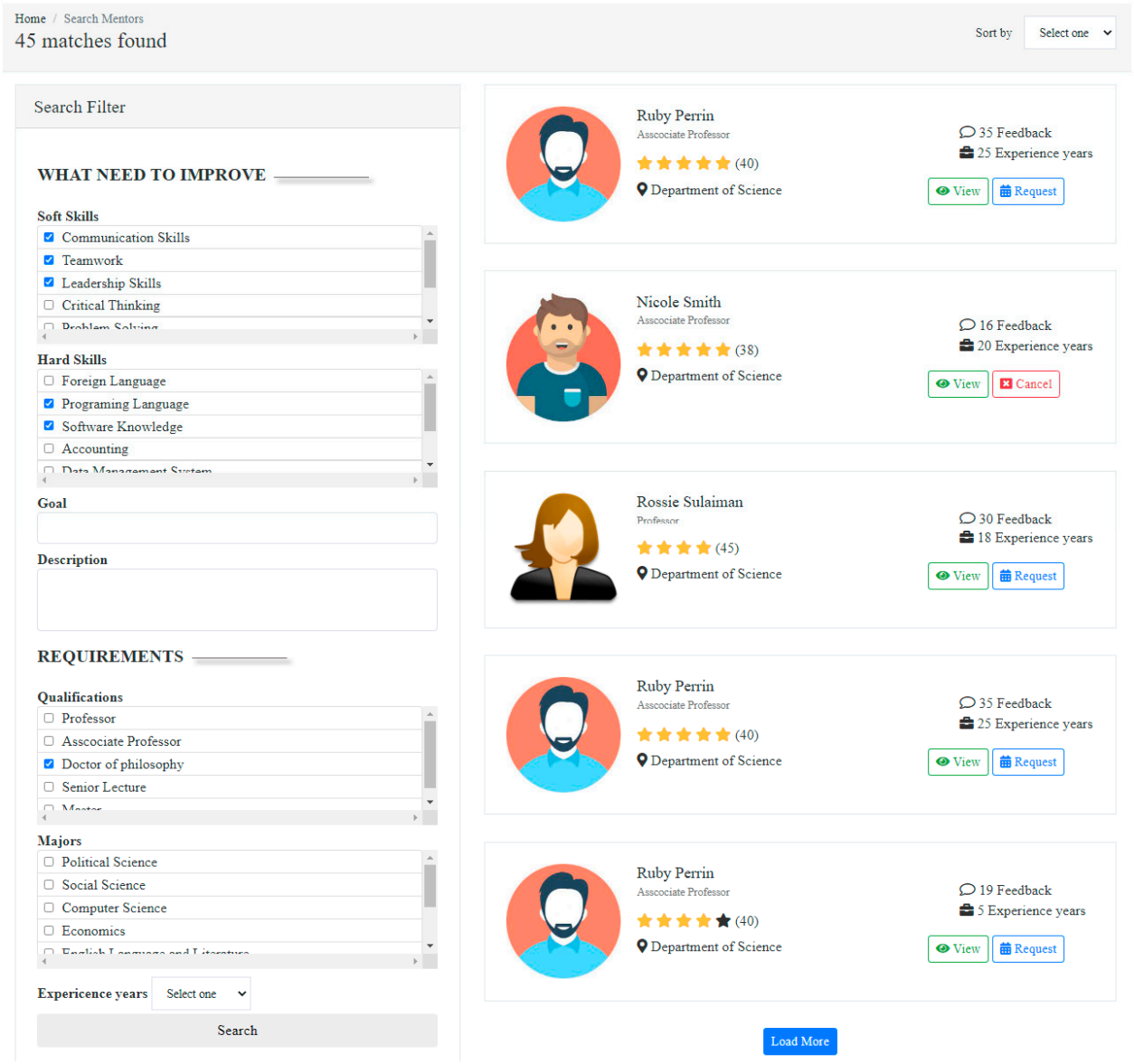


Figure 19. Search mentors.

Similar to collaborative learning, mentees engage in learning activities that are designed and adjusted by mentors to support learners in reaching their goals more effectively. After this, the mentees have the responsibility to carry out all the tasks, including participating in lessons and completing assignments, which will be used to evaluate their learning process. Moreover, they can share their own resources and manage their discussions (shown in Figure 20).

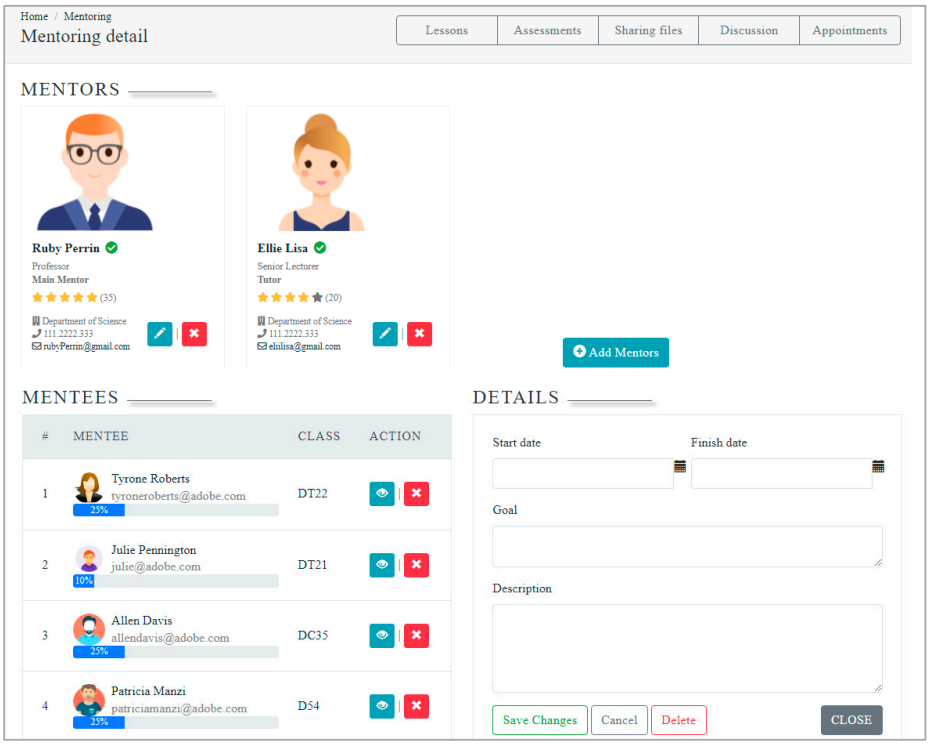


Figure 20. Mentoring detail.

4.2.4. Monitor the Learning Process

At the beginning of the mentoring process, a mentor decides what pedagogies are suitable to help the mentees achieve their goals. Throughout the learning process, the mentor monitors the mentees' progress (shown in Figure 20) and adjusts the objectives of the lessons and activities to suit the learners' goals. The evaluation is based on how well the learners complete the tasks based on the due date and the level they achieve for each activity (Figures 20 and 21).

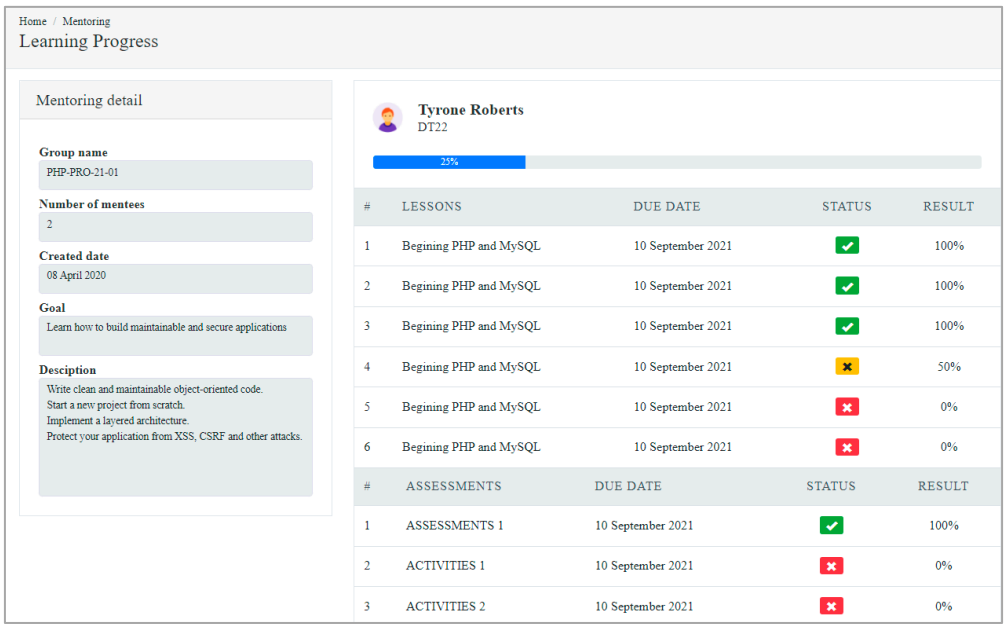


Figure 21. Learning progress.

This implementation section shows how collaborative learning helps learners acquire knowledge from their interactions with peers and resource sharing. Moreover, learners are able to achieve their goals more easily and effectively through their connection with a wide professional community and suitable curriculum adjustments in the e-mentoring process. However, to demonstrate the usefulness of the proposed model and the feasibility of its implementation, evaluation is necessary. The evaluation stage is detailed in the next section.

5. Evaluation

This research centres on enhancing collaborative learning and e-mentoring in a smart education system in the higher education sector to foster the learners' skills. The evaluation stage plays an important role in demonstrating the feasibility and efficiency of the proposed model. Hence, we conducted surveys with the facilitators and learners who are currently working or pursuing a postgraduate qualification in eleven universities and academies in the Vietnamese military. The reason for conducting the surveys in these institutions is due to their plans to develop a smart education environment and the need to connect learning communities in specific fields. It was anticipated that the questionnaires would uncover useful ideas and varying opinions from the participants on their experience of moving from a traditional learning method to a smart learning approach. The questionnaires were designed using the Google Form application because they are easily created and shared online; moreover, participants can use any mobile device, tablet, or computer to respond, and the results can be analysed in real time.

Two surveys were used for the evaluation, one for facilitators and the other for learners; this is because the success of applying a new learning strategy is evaluated based on the satisfaction and effective collaboration between learners and facilitators. Data analysis was performed using SPSS, and the statements and descriptive statistics are shown in Tables 1–3. The two questionnaires had the same structure, but the questions varied. All the questions were translated into Vietnamese to ensure the ideas were transparent and to avoid misunderstanding. The questionnaires comprised two sections with optional textboxes for the participants to comment on how the two learning strategies could be improved. The first section focuses on initial ideas about how the system is mainly developed and how the framework supports their learning. The second section provides an opportunity for the learners to indicate their level of satisfaction with all the main functionalities that the tool supports, which are (1) collaborative learning: search groups and join an existing group, create new group, collaborative learning activities, and peer reviews, and (2) e-mentoring: create an obligatory mentoring group, create a free mentoring group, manage and conduct mentoring activities, and monitor the learning process. We provided step-by-step instructions with screenshots of the main interfaces of the experiment tool before they attempted the survey questions and were given the URL of the platform to participants. Therefore, participants had a clear view of how to conduct collaborative learning and e-mentoring tasks before experiencing the main features through the tool. The participants were required to express their level of agreement or disagreement using a 5-point Likert scale from 1–5 to indicate their response as either strongly disagree, disagree, neutral, agree, or strongly agree, respectively.

Table 1. Descriptive statistics of the facilitators' agreement with each statement of the survey.

#	Question	#	Question
Section 1			
1. Learners should actively discuss and maintain interactions to acquire in-depth knowledge and accumulate soft skills for their future work.		2. Maintaining interactions with each other will help learners exchange knowledge and experience.	

Table 1. *Cont.*

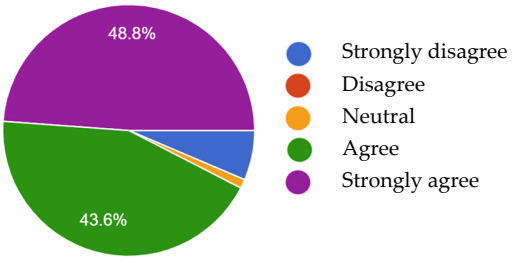
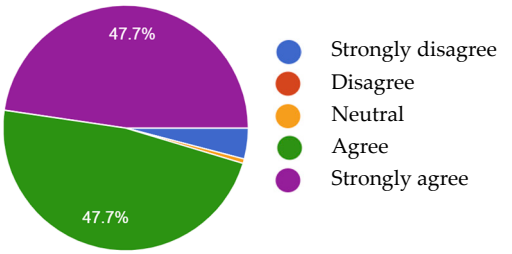
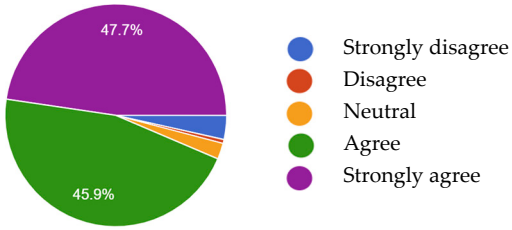
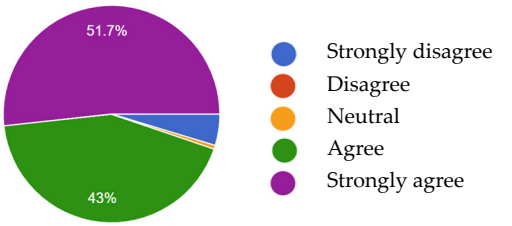
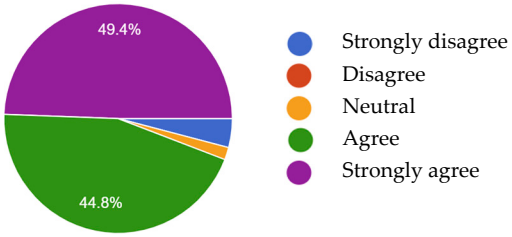
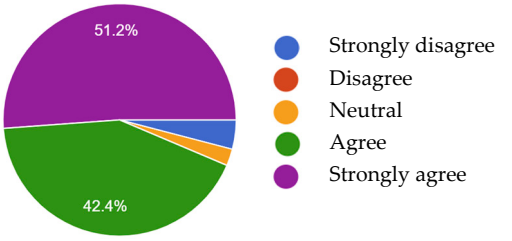
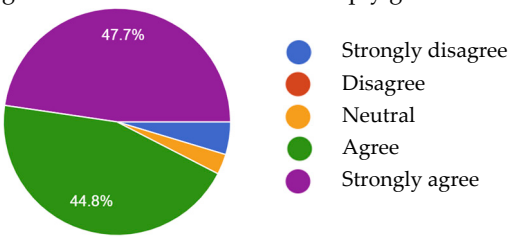
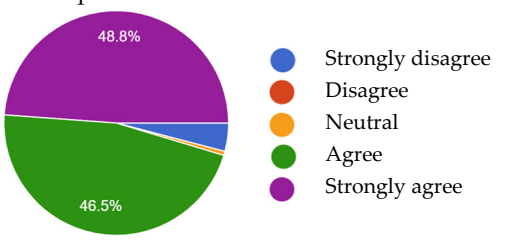
#	Question	#	Question
	3. Resource-sharing repositories help learners exchange knowledge and experience.		4. The support of mentors to construct knowledge is vitally important for learners to achieve their goals.
	5. Connecting to a wide range of professional communities gives learners the opportunity to receive effective guidance.		6. Connecting to a wide range of professional communities enables learners to construct knowledge.
	7. An effective method to help learners acquire valuable knowledge and skills is to provide feedback and guide them to generate ideas rather than to simply give them the solutions.		8. An effective method to assist learners in achieving their goals is to design a specific curriculum based on their levels and improvements.
			

Table 2. Histogram showing the results of the facilitators' survey when using the tool.

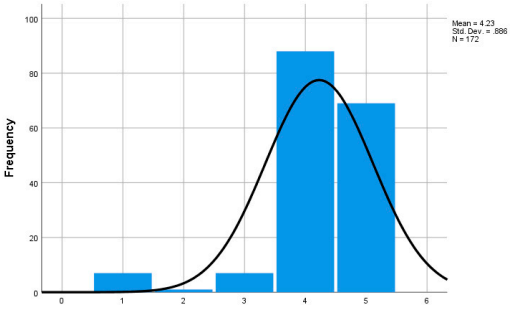
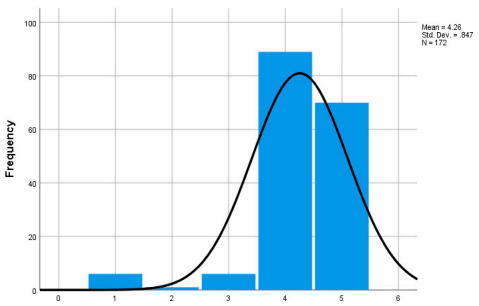
#	Question	#	Question
Section 2 1. The tool would help me find an existing group.		2. The tool would help me build an effective learning group.	

Table 2. *Cont.*

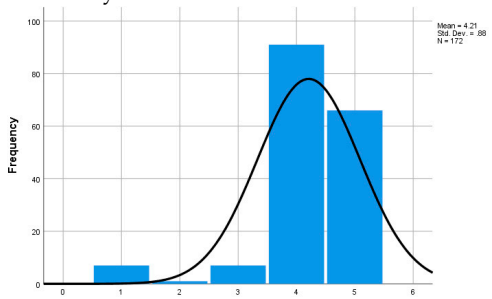
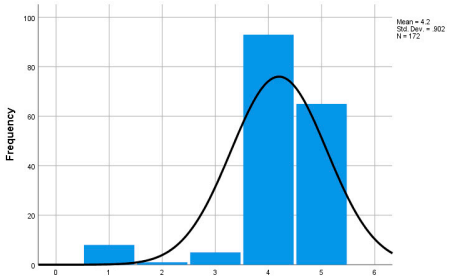
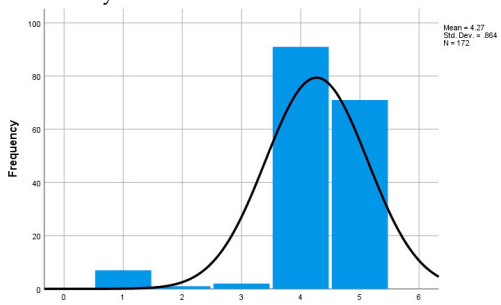
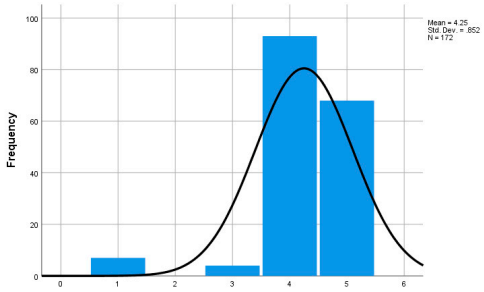
#	Question	#	Question
3. The tool would help me manage the peer review easily and effectively. 		4. The tool would provide a clear view of the learners' background and their goals. 	
5. The tool would help me organize lessons and resources more effectively. 		6. The tool would help me to monitor each learner's improvement process. 	

Table 3. Descriptive statistics of the learners' agreement with each statement of the survey.

#	Question	N	Min	Max	Mean	Std. Dev.
Section 1						
1	Exchanging knowledge and experience would foster my in-depth understanding and necessary skills.	388	1	5	4.29	1.165
2	Interactions amongst peers would effectively help me exchange knowledge and experience.	388	1	5	4.26	1.082
3	Resource-sharing repositories would effectively help me exchange knowledge and experience.	388	1	5	4.18	1.147
4	The guidance and support of mentors in generating ideas are vitally important for me to stay on the right path to success.	388	1	5	4.30	1.085
5	The support of mentors in constructing knowledge is vitally important for me to achieve my goals.	388	1	5	4.29	1.049
6	Connecting to a wide range of professional communities would provide me with the opportunity to receive effective guidance.	388	1	5	4.25	1.062
7	Connecting to a wide range of professional communities would provide me with the opportunity to construct knowledge effectively.	388	1	5	4.24	1.070
8	A flexible curriculum which is adjustable based on my level and improvement would help me enhance my knowledge.	388	1	5	4.30	1.078
Section 2						
9	The tool would help me find an existing group easily.	388	1	5	4.12	1.037
10	The tool would help me build an effective group of learning.	388	1	5	4.08	1.013
11	The tool would help me maintain interactions constantly and conveniently.	388	1	5	4.13	1.010
12	The tool would help me share and access resource repositories easily.	388	1	5	4.16	0.972
13	The tool would help me to perform a peer review easily and effectively.	388	1	5	4.13	0.998
14	The tool would provide me with the opportunity to connect to a wide range of professional communities.	388	1	5	4.12	1.010
15	The tool would help me to choose mentors who are well-matched with my requirements.	388	1	5	4.18	0.957

A total of 172 completed questionnaires were received from the facilitators. Interestingly, the participants expressed diverse views in their responses to the questionnaire, but the majority of respondents agreed with most of the questions in the questionnaire. The

first three questions evaluated to what extent they agreed with the idea that collaborative learning helps learners achieve their goals (addressed in H1, H2, and H3). The first question evaluated whether learners should discuss and actively maintain interactions with facilitators to acquire in-depth knowledge and soft skills to benefit them in their future careers. The second question evaluated the idea that the interactions would help learners exchange knowledge and experience. The third question evaluated whether resource-sharing repositories would help learners exchange knowledge and experience. About 92% to 95% of the participants agreed and strongly agreed with the ideas presented in questions 1–3, while less than 6.4% disagreed.

The next five questions evaluated the respondents' level of agreement that e-mentoring assists learners in succeeding in their learning pathways. To evaluate H8, the fourth question asked the respondents to rate their level of agreement on the importance of the mentors' support in constructing knowledge in relation to the learners' success. Nearly 95% of the participants answered that this support is extremely important for learners. The fifth and sixth questions evaluated the respondents' level of agreement with the notion that connecting to the wider professional community provides learners with more opportunities to receive guidance and to be assisted in constructing knowledge (addressed in H5 and H4). The majority of respondents (94.2% and 93.6%) agreed with questions 5 and 6, respectively. The seventh question evaluated whether an effective method to help learners acquire valuable knowledge and skills is to provide feedback and to guide them to generate ideas rather than to give them the solutions (H6), receiving a 92.5% positive response. The eighth question evaluated to what degree the respondents agreed that an effective method to assist learners in achieving their goals is to design a specific curriculum based on their levels and improvements (H7), receiving a 95.3% positive response.

In the second section, after performing a set of tasks and experiencing the features of the tool while following the given instructions, the participants were asked to rate the statements on a five-point Likert scale. As shown in Table 2, there are six statements in the second section, three addressing the effectiveness of the application in supporting learners in a collaborative learning setting and the other three addressing the effectiveness of the tool in assisting learners in e-mentoring. Statement 1 and statement 2 address the first stage in collaborative learning, where learners want to participate in a suitable group by finding and asking to join an existing group or build a new group. Most participants indicated that they thought the tool supported learners easily, with 91.3% finding an existing group, and 92.4% forming a new efficient group. Moreover, 91.3% of the participants strongly agreed and agreed with the effectiveness of managing the peer-review works, which is addressed in statement 3.

The last three statements required the participants to evaluate the effectiveness of several specific features of e-mentoring. The majority of participants agreed with the statements. In response to statement 4, 91.9% of participants agreed that the tool provided a clear view of the learners' backgrounds and goals. Because organizing lessons and learning resources are similar in collaborative learning and e-mentoring, statement 5 asked the participants to indicate what they thought of this feature in the tool. Only 4.7% of participants stated that the tool did not assist them in managing lessons and resources effectively, whereas 94.2% provided contrary responses. For the last statement, 93.6% of participants indicated that they felt the tool helped them to monitor each learner's improvement effectively.

As for the learners' survey, in total, 388 completed responses were received. The content of the first section of eight questions for the learners was the same as the first section for the facilitators; however, it focused on the learners' perspective. The results shown in Table 3 with mean values greater than 4.20 indicate a high level of agreement for all the questions. Moreover, the next seven statements in the second section evaluated the satisfaction of learners in experiencing collaborative learning and e-mentoring. Learners were provided with detailed instructions on how to find an existing group or create a new group with common goals, as well as the ways they maintain interactions, share resources,

perform peer-review works, connect to a wide range of professional communities, and choose mentors who are well-matched to their requirements. Considering the mean and standard deviation scores for each statement, most items have a mean value of between 4.08 and 4.18 and a standard deviation of around 1, which indicates that the participants agreed with all the statements and formed similar opinions, while the minority rated the application as not really effective in terms of supporting their learning.

Two open-ended questions invited participants to write comments about the tool. Of the 172 surveys completed by the facilitators, a total number of 97 responses were received for collaborative learning, and 92 responses were received for e-mentoring. The results show that almost all facilitators were interested in the way the application supported them in exchanging and learning with their colleagues and more experienced professors and guiding their learners. Some of their positive feedback statements are "It is great that we have been given various opportunities to connect to experts in different fields", "Reviewing academic work is much quicker and more effective as authors and reviewers can do the work directly with the tool", "The tool helps us to monitor and evaluate the learning processes visually; also, discussion boxes encourage learners to share their thoughts naturally which enhances our professional ethics and pedagogical skills". We also received some useful comments to improve the application, for example: "The team leader should understand the strengths and the weaknesses of each member to assign suitable tasks"; "Each member in a group should take a specific responsibility which would be checked regularly to ensure the efficiency of the group"; "If a mentor declines a learner's request, the tool should suggest other mentors who are suitable in relation to the learner's criteria".

Of the 388 responses from the learners, 177 responses were received for collaborative learning, and 174 responses were received for e-mentoring. Similar to the facilitators' surveys, most of the learners expected to experience new learning approaches that would help them reach their goals by flexibly connecting them with a wide range of professional communities and providing various opportunities to communicate and exchange knowledge. Many of the learners' comments express their positive experience with the tool: "The tool helps us to not only be receivers of knowledge but also sharers which ignites our passion and helps us to assert ourselves"; "The tool provides us with a comfortable learning environment as facilitators or mentors accompany us through the learning process"; "We were really impressed with the e-mentoring strategy which suggests suitable mentors based on our requirements with useful information, so we could make an effective choice". Moreover, several comments aiming to improve the tool are "The team leader should take the responsibility to monitor, give instructions, and manage the group's activities to ensure the effectiveness of the group", "Resource sharing should be reviewed and approved before updating to the common repository to ensure the scientific quality of resources", "For each group, the number of members should be limited to make effective use of each member's responsibility", "To perform the two learning strategies effectively, besides the flexibility, the learning program should be varied with diverse activities to engage learners, or combine different learning strategies flexibly".

The large number of positive results and feedback indicates the feasibility and effectiveness of the research. Both learners and facilitators are expecting an educational transformation to more modern and flexible learning approaches, as collaborative learning and e-mentoring become two learning strategies that effectively assist them in succeeding in their learning pathways. Moreover, the designed functions ensure that the learning processes are smoother and more effective, and participants strongly believe that the proposed framework will meet their expectations. However, the learners' suggestions indicate that the framework should be improved to assist facilitators and learners more efficiently and more rigorously in assigning members' roles, limiting group numbers, and improving the quality of the resources in shared workplaces, where the integration of supporting tools can be considered if deemed necessary.

6. Conclusions

Implementing a smart education system is important in today's era of digital transformation. A smart learning system comprises intelligent pedagogies in a sophisticated learning environment supported by technological advances to foster a competent workforce. In addition to mastering foundation knowledge and skills, learners are required to acquire certain competencies to successfully perform all the tasks associated with the changes in today's highly technological society. Learners are no longer studying alone, or within the boundaries of their training institutions, but are exposed to valuable opportunities to learn from colleagues or strengthen their knowledge and skills by connecting to a wide body of professional communities. The purpose of this research is to propose a smart learning system that enhances collaborative learning and e-mentoring in higher education. The framework comprises two effective learning strategies, namely, collaborative learning and e-mentoring.

To address the theory effectively, we proposed a model with a set of hypotheses. We argued that a learner's achievement and motivation can be enhanced by collaborative learning and e-mentoring. Furthermore, when engaging in high-quality social interaction and resource sharing, learners are exposed to valuable opportunities to exchange knowledge and experience. E-mentoring assists learners in overcoming difficulties in gaining mastery of new skills and knowledge by providing a learning environment where they can connect to professional communities and experience flexible curriculums that are adjusted to be more suitable for learners' improvement. Through e-mentoring, learners receive personalised guidance in generating ideas and constructing knowledge to improve their skills and develop self-confidence [29].

The paradigm has been implemented as a web application to demonstrate the effectiveness of the proposed model in a smart education environment. The collaborative learning framework enables users to build a group with common goals or to search for a group that has the same goals as they do. They engage in learning using a joint workspace where they can share resources, learn new concepts, discuss and deal with uncertain theories, and construct ideas together. Moreover, the application enables them to learn both synchronously and asynchronously using a range of multimedia and devices.

Similarly, in this framework, e-mentoring assists learners from the matching stage onward to maintain mentor–mentee relationships and evaluate the results. Mentees can be required to participate in the mentoring process, or they can proactively search for mentors who meet their requirements. Learners engage in the learning process by following curriculums designed by mentors, including lectures and activities. The progress of learners is monitored and evaluated based on their achievements and improvement, which provides helpful evidence that can be used by mentors to access and improve their learning programs.

To demonstrate the usefulness and feasibility of the proposed model, two surveys with similar structures were conducted to evaluate the proposed framework and its functionality from the perspective of facilitators and learners. The questionnaires were divided into two parts, one focusing on the theory, which relates to the hypotheses about participants, and the other, focusing on the implementation part. The questionnaires were designed in the Google Form application in the Vietnamese language because all participants are working and pursuing postgraduate programs in Vietnamese military academies. Our purpose was to collect feedback on whether facilitators and learners agreed with the statements describing how collaborative learning and e-mentoring assist learners to be successful. The great majority of respondents agreed with all the statements with constructive comments. Thus, the research model is effective in addressing the requirement of developing a smart education environment for a future high-quality workforce.

This study analyses how collaborative learning and e-mentoring support learners in higher education. The evaluation was conducted in a specific learning environment, namely, Vietnamese military institutions, because this organization is pushing for the implementation of a smart education platform and the requirements of working cooperatively

and connecting across the organization. To broaden the intelligent features of these two learning approaches so they are applicable to different learning environments, future research will examine whether they support learners in other learning environments, such as vocational education or secondary education, and more responses from various types of learners will be collected.

The framework also helps learners complete learning activities, as they can study synchronously or asynchronously, and question, refer, and respond to one another's ideas via discussion boxes. However, participants require diverse activities to motivate and engage them in the learning process. Learners with different levels of knowledge and experience may expect specific activities that not only build teamwork skills but also immerse learners in interactive problem-solving scenarios. One of the growing trends of education that needs to be considered as a learning activity in future research is the gamification of virtual reality, especially in the case of training practice skills for specialists using modern digital solutions, such as in the mining [52] and medical fields. A successful course includes a vibrant mix of activities, which requires future work to identify which will be the most suitable for learners and integrate supporting components to the tool as necessary.

Additionally, the framework helps learners by suggesting groups or mentors that are a suitable match based on specific criteria, such as their goals, required qualifications, majors, and years of experience. Without assistance from the framework, learners may experience difficulties searching for an appropriate mentor or group from a large professional community. Throughout the learning process, the facilitators monitor the ways learners complete assigned tasks and evaluate and adjust the curriculum to better suit the learners' goals. For this reason, to provide learners with a more sophisticated learning environment, future work will integrate AI and machine learning algorithms to undertake an advanced analysis on the platform to recommend a better matching process and suggest the most suitable learning curriculums for individuals based on their requirements, personality traits, and learning habits.

In this research, the main focus was on two learning approaches, collaborative learning and e-mentoring, both of which help learners achieve their academic goals by connecting them to a wide range of professional communities. However, there are countless pedagogies that can engage learners and help them develop higher-order thinking skills and understand how to relate their learning to the world around them. Flexibly implementing different pedagogical techniques in a smart educational environment is of vital importance to ensure that learners can tackle learning in a way that best meets their needs. Future work will investigate other learning strategies to gain a deeper grasp of which pedagogy best suits learners in specific circumstances. Pedagogical approaches for higher education that can be considered are constructivist learning, inquiry-based learning, integrative learning, and the reflective approach.

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References

1. Azam, M.; Nouman, M.; Gill, A.R. Impacts of information technology on society in the new century. *Preprints. Org.* **2022**, *2022*, 2022070283.
2. Haleem, A.; Javaid, M.; Qadri, M.A.; Suman, R. Understanding the role of digital technologies in education: A review. *Sustain. Oper. Comput.* **2022**, *3*, 275–285. [CrossRef]
3. Laverick, D.M. *Mentoring Processes in Higher Education*; Springer: Berlin/Heidelberg, Germany, 2016.
4. Parchure, A.; Gosavi, S. Learning strategies: Impact of emerging hybrid model of learning. *TMV's Knowl. Resour. Cent. Digit. Repos.* **2022**, *24*, 41–46.
5. Azmi, A.N.; Kamin, Y.; Noordin, M.K.; Nasir, A.N.M. Towards industrial revolution 4.0: Employers' expectations on fresh engineering graduates. *Int. J. Eng. Technol.* **2018**, *7*, 267–272.
6. Lase, D. Education and industrial revolution 4.0. *J. Handayani Pgsd Fip. Unimed.* **2019**, *10*, 48–62. [CrossRef]
7. Zhu, Z.-T.; Yu, M.-H.; Riezebos, P. A research framework of smart education. *Smart Learn. Environ.* **2016**, *3*, 1–17. [CrossRef]
8. Nafea, R.M.E.D.; Toplu, E.K. Future of Education in Industry 4.0: Educational Digitization–A Canadian Case Study. In *Research Anthology on Digital Transformation, Organizational Change, and the Impact of Remote Work*; IGI Global: Hershey, PA, USA, 2021; pp. 1977–1997.
9. Scager, K.; Boonstra, J.; Peeters, T.; Vulperhorst, J.; Wiegant, F. Collaborative learning in higher education: Evoking positive interdependence. *CBE—Life Sci. Educ.* **2016**, *15*, ar69. [CrossRef] [PubMed]
10. Jeong, H.; Hmelo-Silver, C.E. Seven affordances of computer-supported collaborative learning: How to support collaborative learning? How can technologies help? *Educ. Psychol.* **2016**, *51*, 247–265. [CrossRef]
11. Chi, M.T.; Roy, M.; Hausmann, R.G. Observing tutorial dialogues collaboratively: Insights about human tutoring effectiveness from vicarious learning. *Cogn. Sci.* **2008**, *32*, 301–341. [CrossRef]
12. Aderibigbe, S.A.; Colucci-Gray, L.; Gray, D. Mentoring as a collaborative learning journey for teachers and student teachers: A critical constructivist perspective. *Teach. Educ. Adv. Netw. J.* **2014**, *6*, 17–27.
13. Ragins, B.R.; Kram, K.E. *The Handbook of Mentoring at Work: Theory, Research, and Practice*; Sage Publications: New York, NY, USA, 2007.
14. Elbestawi, M.; Centea, D.; Singh, I.; Wanyama, T. SEPT learning factory for industry 4.0 education and applied research. *Procedia Manuf.* **2018**, *23*, 249–254. [CrossRef]
15. Ibrahim, N.; Al Ani, I.I. Smart Learner-Centric Learning Systems. In Proceedings of the Information Science and Applications 2017, Macau, China, 20–23 March 2017; pp. 577–584.
16. Asoodar, M.; Vaezi, S.; Izanloo, B. Framework to improve e-learner satisfaction and further strengthen e-learning implementation. *Comput. Hum. Behav.* **2016**, *63*, 704–716. [CrossRef]
17. MirsaeedGhazi, T.; Kharrat, M.; Kardan, A.; Eghbali, N. A framework for learner preparation and support in academic e-learning environment. *Int. J. Inf. Commun. Technol.* **2011**, *3*, 33–41.
18. Madhusudhana, K. Learner Cognitive Behavior and Influencing Factors in Web-based Learning Environment. *Int. J. Adv. Comput. Sci. Appl.* **2018**, *9*, 542–546. [CrossRef]
19. Le, H.; Janssen, J.; Wubbels, T. Collaborative learning practices: Teacher and student perceived obstacles to effective student collaboration. *Camb. J. Educ.* **2018**, *48*, 103–122. [CrossRef]
20. Zhang, Q.; Long, L. Didactics of smart pedagogy: Smart pedagogy for technology enhanced learning. In *Innovations in Education and Teaching International*; Daniela, L., Ed.; Springer: Cham, Switzerland, 2021.
21. Tomlinson, C.A.; McTighe, J. *Integrating Differentiated Instruction & Understanding by Design: Connecting Content and Kids*; ASCD: Alexandria, VA, USA, 2006.
22. Kallel, I.; Chniter, M. Building Collaborative e-Learning Teams in a Smart Education Environment. In Proceedings of the 2019 IEEE International Smart Cities Conference (ISC2), Casablanca, Morocco, 14–17 October 2019; pp. 324–329.
23. Quinnell, K. Mentoring organically. In *Beyond Mentoring*; Elsevier: Amsterdam, The Netherlands, 2017; pp. 5–18.
24. Mullen, C.A. Alternative mentoring types. *Kappa Delta Pi Rec.* **2016**, *52*, 132–136. [CrossRef]
25. Sohn, M.; Kwon, Y.M.; Lee, H.J. Context-based hybrid semantic matching framework for e-mentoring system. In Proceedings of the 2012 15th International Conference on Network-Based Information Systems, Melbourne, Australia, 26–28 September 2012; pp. 691–696.
26. Neely, A.R.; Cotton, J.; Neely, A.D. E-mentoring: A model and review of the literature. *AIS Trans. Hum. Comput. Interact.* **2017**, *9*, 220–242.
27. Lavin Colky, D.; Young, W.H. Mentoring in the virtual organization: Keys to building successful schools and businesses. *Mentor. Tutoring* **2006**, *14*, 433–447. [CrossRef]
28. Gay, B. What is mentoring? *Educ. Train.* **1994**, *36*, 4–7. [CrossRef]
29. Tinoco-Giraldo, H.; Torrecilla Sanchez, E.M.; García-Peñalvo, F.J. E-mentoring in higher education: A structured literature review and implications for future research. *Sustainability* **2020**, *12*, 4344. [CrossRef]
30. Cho, Y.H.; Lim, K.Y. Effectiveness of collaborative learning with 3 D virtual worlds. *Br. J. Educ. Technol.* **2017**, *48*, 202–211. [CrossRef]
31. Moskaliuk, J.; Bertram, J.; Cress, U. Training in virtual environments: Putting theory into practice. *Ergonomics* **2013**, *56*, 195–204. [CrossRef]

32. Miller, M.; Hadwin, A. Scripting and awareness tools for regulating collaborative learning: Changing the landscape of support in CSCL. *Comput. Hum. Behav.* **2015**, *52*, 573–588. [CrossRef]
33. Ward, V.; Smith, S.; House, A.; Hamer, S. Exploring knowledge exchange: A useful framework for practice and policy. *Soc. Sci. Med.* **2012**, *74*, 297–304. [CrossRef] [PubMed]
34. Zachary, L.J.; Fischler, L.A. *The Mentee's Guide: Making Mentoring Work for You*; John Wiley & Sons: Hoboken, NJ, USA, 2009.
35. Aarnio, M. Collaborative Knowledge Construction in the Context of Problem-Based Learning: Exploring Learning from Conflicting Ideas and Knowledge. Ph.D. Thesis, University of Helsinki, Helsinki, Finland, 2015.
36. Pangil, F.; Mohd Nasurddin, A. Knowledge and the importance of knowledge sharing in organizations. In Proceedings of the Conference on Business Management Research, Malaysia, Sintok, 11 December 2013.
37. Bartholomé, T.; Stahl, E.; Pieschl, S.; Bromme, R. What matters in help-seeking? A study of help effectiveness and learner-related factors. *Comput. Hum. Behav.* **2006**, *22*, 113–129. [CrossRef]
38. Fulk, J.; Monge, P.; Hollingshead, A.B. Knowledge resource sharing in dispersed multinational teams: Three theoretical lenses. In *Managing Multinational Teams: Global Perspectives*; Emerald Group Publishing Limited: Bingley, UK, 2005.
39. Learning, C. Foundations for a CSCL Community. In Proceedings of the CSCL, Boulder, CO, USA, 7–11 January 2002; pp. 7–11.
40. Kaplan, S. *Strategies for Collaborative Learning: Building eLearning and Blended Learning Communities*; iCohere, Inc.: Walnut Creek, CA, USA, 2002.
41. Tillema, H.; van der Westhuizen, G.J.; Smith, K. *Mentoring for Learning: Climbing the Mountain*; Springer: Berlin/Heidelberg, Germany, 2015.
42. Van Aalst, J. Distinguishing knowledge-sharing, knowledge-construction, and knowledge-creation discourses. *Int. J. Comput. Support. Collab. Learn.* **2009**, *4*, 259–287. [CrossRef] [PubMed]
43. Center for Health Leadership & Practice. "Guía de Mentoría: Guía para Mentores" (2003). Ethics in Science and Engineering National Clearinghouse. 305. Available online: https://scholarworks.umass.edu/esence/305 (accessed on 28 December 2023).
44. DuBois, D.L.; Karcher, M.J. *Handbook of Youth Mentoring*; Sage Publications: Thousand Oaks, CA, USA, 2013.
45. Scheurs, J.; Dumbraveanu, R. A shift from teacher centered to learner centered approach. *Learning* **2014**, *1*, 31–37.
46. Janssen, J.; Erkens, G.; Kanselaar, G. Visualization of agreement and discussion processes during computer-supported collaborative learning. *Comput. Hum. Behav.* **2007**, *23*, 1105–1125. [CrossRef]
47. Bada, S.O.; Olusegun, S. Constructivism learning theory: A paradigm for teaching and learning. *J. Res. Method Educ.* **2015**, *5*, 66–70.
48. Shukor, N.; Tasir, Z.; van der Meijden, H.; Harun, J. Exploring students' knowledge construction strategies in computer-supported collaborative learning discussions using sequential analysis. *J. Educ. Technol. Soc.* **2014**, *17*, 216–228.
49. Bernáld, H.; Cajander, Å.; Daniels, M.; Laxer, C.; Bernáld, H.; Cajander, Å.; Daniels, M.; Laxer, C. Reasoning about the value of cultural awareness in international collaboration. *J. Appl. Comput. Inf. Technol.* **2011**, *15*, I2.
50. Parker-Katz, M.; Bay, M. Conceptualizing mentor knowledge: Learning from the insiders. *Teach. Teach. Educ.* **2008**, *24*, 1259–1269. [CrossRef]
51. Abu-Abed, F.; Zhironkin, S. New Game Artificial Intelligence Tools for Virtual Mine on Unreal Engine. *Appl. Sci.* **2023**, *13*, 6339. [CrossRef]
52. Kumar, A.; Saudagar, A.K.J.; Alkhathami, M.; Alsamani, B.; Khan, M.B.; Hasanat, M.H.A.; Ahmed, Z.H.; Kumar, A.; Srinivasan, B. Gamified Learning and Assessment Using ARCS with Next-Generation AIoMT Integrated 3D Animation and Virtual Reality Simulation. *Electronics* **2023**, *12*, 835. [CrossRef]