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Undefined Socio-Affective Scenarios in a Virtual Learning Environment

A View from Learning Analytics

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Abstract—There is a growing number of virtual courses being offered by Brazilian educational institutions, requiring the development of technological resources and research to assist in the teaching and learning processes in Distance Education (DE). The analysis of the students' socio-affective profiles in Virtual Learning Environments (VLE) enables possibilities to develop methodologies and/or resources to better understand them. The Social Map (SM) and Affective Map (AM), both features of the Cooperative Learning Network (ROODA in Portuguese), provide inferences and graphic presentations of students' socio-affective profiles. Thus, this article aims to identify students with Undefined Socio-affective Scenarios in a VLE, based on Learning Analytics (LA). LA is defined as the measurement, collection, and analysis of data. This qualitative and quantitative research approach was carried out based on 10 case studies. The target audience was divided between 77 undergraduate students, 29 graduate students, 27 elderly people, and 86 professors who participated in teaching activities at a Brazilian public university. Data collected from the SM and AM were extracted in order to identify the relationship between these two aspects. The result was 18 Socio-affective Scenarios using LA and the identification of 108 Pedagogical Strategies to contribute to the analysis of students' learning profiles.

Keywords—learning analytics, socio-affective scenarios, virtual learning environments

1 Introduction

Distance Education (DE) has transformed over the past ten years, and consequently, virtual course offerings have increased in order to make education available throughout Brazil [1]. This modality brings the flexibility of time and place to study but makes physical interaction between the parties involved in the teaching and learning process more difficult. In fact, there are great challenges when it comes to following each

student's distance learning trajectory. It is therefore necessary to develop and employ different strategies to increase students' DE success rates [2].

By valuing more comprehensive studies, educators can make important moves to explore social and affective dimensions. This study understands the construction of knowledge based on the work of Piaget [3, 4], in which social exchanges and affectivity play specific and vital roles for both teaching and learning. From the Piagetian perspective, social interactions form a link between the subject-environment and, thus, foster discussions about the learning object, causing new cognitive structures to be built. On the other hand, affect is linked to the motivation to discover, awakening an interest in research, acting as the driving force behind the individual's actions [4].

Thus, according to Dolle [5], the subject learns not only by internal affective and cognitive processes, but especially by the demands caused by their social relationships. In fact, the relationships established between professor, student, object of knowledge, and the environment represent essential aspects in teaching and learning. These exchanges train individuals beyond the construction of knowledge, such as living in society. The affective and social attributes are inherent, deeply conditioning cognitive processes [4, 6].

Therefore, although tools are constantly improving and consequently positively affecting distance learning, many issues remain in this teaching modality, such as the recognition of students' affective manifestations and the interactions that emerge (or not) in these spaces. Thus, if professors were provided with this information, they would have essential elements to meet the demands of their students by offering them adequate help [7].

Understanding the interests and particularities of the students and bringing the actors involved closer together would enhance the relationships that occur in the teaching and learning processes. In fact, the Learning Analytics (LA) research area emerged in 2010 as a solution to address this new need to analyze the interactions carried out in these spaces. It is based on web analytics and initially emerged to serve only students facing difficulties. However, it is currently used to monitor all students' trajectories, allowing for individualized analysis [8, 9], yet studies using LA in the Brazilian context in Virtual Learning Environments (VLE) are recent and scarce [10].

Given this panorama, the study that underlies this article starts with a reflection on the social and affective aspects in a VLE. The objective of the research presented in this article is to identify the possible recurrent Undefined Socio-affective Scenarios, based on LA, in the Cooperative Learning Network (ROODA in Portuguese) VLE and propose Pedagogical Strategies (PSs) to support teaching actions in this context. Scenarios are understood here as the mapping between the indicators of the Affective Map (AM) and the Social Map (SM) presented in ROODA. The AM addresses personality and behavioral factors to infer and recognize what the learner's mood may be: Animated, Discouraged, Satisfied and Dissatisfied. The SM maps and presents information regarding the student's interactions obtained in a VLE in a graph. In turn, the social interactions detected by the SM refer to the indicators: Absence, Collaboration, Feeling separate from the class, Drop out, Informal Groups, and Popularity. Only some of these indicators occur simultaneously. Thus, Scenarios are composed of combinations of the student's affective state inferred by the AM and the student's social interaction

indicators detected by the SM. A Scenario therefore represents one or more occurrences of a given affective state with distinct variations of social interactions.

This paper presents the process of mapping Undefined Socio-affective Scenarios and the elaboration of PSs to specifically address each. Based on the strategies developed and recommended, a professor can apply educational practices appropriate to this situation and make decisions based on the needs and interests of students with Undefined profiles. Thus, this article is organized into seven sections. The following section discusses the ROODA VLE as well as the social and AMs. The third section discusses LA. The fourth section describes the concept of PSs. The research methodology is presented in the fifth section. The sixth section presents the results that were obtained. Finally, conclusions are offered.

2 The ROODA virtual learning environment: A focus on affective and social maps

The Cooperative Learning Network VLE (ROODA), is user-centered and enables access to materials and tools as well as spaces for exchanging and sending activities with the aim of providing a place for interaction between its participants. Thus, because it is an environment used by the university, it is constantly being updated in order to keep up with changes in the academic community [11].

Research for this article was done in ROODA, because the VLE was adopted for teaching activities for undergraduate, graduate, and extension courses. ROODA has a total of 26 communication features (synchronous and asynchronous), in addition to the SM and the AM—the latter two are used to identify students' social and affective interactions. The SM and AM are used exclusively by the teacher to graphically display the aspects of the students participating in ROODA. Data are obtained from communication resources such as the logbook, forum, contacts (similar to email), and chat, in addition to comments inserted in the web portfolio and the library [11, 12].

The AM graphically presents the student's mood, which can be Animated, Discouraged, Satisfied, or Dissatisfied, through the analysis of their performance in the environment. A description of the four moods in the AM as defined by Longhi [12] are: Satisfied indicates that the student reveals joy, enthusiasm, satisfaction, and pride in accomplishing the task; Animated shows that the student somehow demonstrates within the affective family of hope, interest, calm, and surprise when facing learning challenges; Discouraged suggests that the student somehow demonstrates or represses the expression of guilt, fear, shame, or sadness for not being able to follow the content, and Dissatisfied expresses or tries not to show irritation, contempt, aversion, and envy. Aggressiveness is often noted, and the student may encourage reprisal or revenge.

The SM tool aims to present the social relationships formed in the environment, making it possible to identify the interactions of the participating subjects in the form of sociograms. It is possible to perceive the social position of each participant and their relationship with the rest of the group. The indicators of social interaction enable the visualization of bonds, influences, and preferences that exist in a certain discipline or in a group [11]. Thus, from the SM, the social indicator degree is calculated, which can

be: Absence, Collaboration, Feelings of separation from the class, Drop out, Informal Groups, and Popularity. Absence: the subject enters the VLE and does not go back to respond to requests from the class (professors, teaching assistants, or students); Collaboration: the user contributes by sharing files, content, images, pages, and links; Feelings of separation from the class: the student sends messages and publishes in the VLE but does not receive feedback from peers; Drop out: this person never accesses the teaching activity (subjects or courses) in question and has not established any exchanges; Informal Groups: the student has exchanged messages between three or more subjects, thus verifying the existence of groups among the participants; and Popularity: the user maintains a higher frequency of interactions in relation to the rest of the class, based on an average among all students, highlighting those who are above average [7].

Thus, both the AM and the SM can assist educators in their virtual pedagogical practices by pointing out the students' profile in a simple graphic way. In the next section, the concept of LA, the reference model, and the general foundational process of this work are explained.

3 Learning analytics

LA emerged as a solution to address the need to enhance the relationships that occur through technology in the teaching and learning processes. In addition to understanding students' interests and needs, it is particularly suited to address students that have difficulties building knowledge [8, 13].

Thus, LA is defined as the measurement, collection, analysis, and reporting of data about students and their learning contexts. Therefore, its focus is to bring together the actors involved and analyze the interactions carried out by students in virtual spaces [14]. Based on a multidisciplinary investigation, Chatti et al. [14] designed a reference model based on four dimensions, which are: what, why, how and who. "What" refers to the types of data collected. These can come from VLE, instructional sources, social networks, among others. "Why" is related to the goals and results of the analysis carried out, which may be: monitoring and analysis, prediction and intervention, tutoring and monitoring, evaluation and feedback, adaptation, reflection, personalization and recommendation. "How" is linked to the different techniques that can be used to detect patterns contained in the data. "Who" is aimed at the public involved, which may be students, professors, educational institutions, researchers, system designers, among others.

In this study, the data collected all came from the ROODA VLE, the goals and results were monitoring, analysis, and personalization. The technique used was manual mapping of the indicators and the target audience was professors and students.

In this context, we emphasize the importance of LA in terms of understanding and optimizing learning, following the students' path, allowing specific and individualized analysis and, thus, considering the LA reference model as well as the indicators mapped in the SM and AM. The concept of PSs is presented below.

4 Pedagogical strategies

PSs are a set of actions planned and implemented by the professor in their educational practice in order to achieve the desired objectives to develop their students. PSs can be suggestions for the use of digital technologies, complementary activities, collective construction of texts, and recommendations for task completion. Using a PS can instigate the interactions as well as the synchronous and asynchronous communications available in a VLE, promoting student dialogue, collaboration, cooperation, active participation, and autonomy [15].

According to Amaral [15], constructing a PS should begin with the analysis of the class profile, i.e., finding out about the students in the DE. Different techniques can be used to do so, such as observing social interactions, applying questionnaires, among others. The creation of a PS requires constant reflection and awareness of the intended goal. Every time the professor elaborates ways to achieve a purpose and establishes actions in the educational process, they are weaving a PS. The author emphasizes the importance of the strategy considering the student's previous development and context, especially the social and affective aspects they have experienced. Thus, only by observing these behaviors can the professor act in a personalized way and design more pertinent PS, contemplating the individual needs of each student.

Moreover, the authors Barvinski et al. [16] establish criteria for a PS to be considered adequate in terms of structure, language, and direction of actions. Action: point out the action to be taken by the professor or teaching assistant; Resources: indicate the resources that can be used to carry out the action (in this research they are: chat, library, contacts, logbook, forum, and web portfolio_; Direct Language: use direct language, subjects are the professor or teaching assistant; and Self-evaluation: suggest that the professor perform a self-evaluation of their pedagogical procedure, verifying the points of their practice that contribute to the student's Socio-affective position (if positive) or restructure the activities and content in order to attempt to remedy the student's negative experience.

Thus, based on these four criteria, the present study developed PS for each Undefined Socio-affective Scenario, incorporating the use of the six features in the ROODA VLE that act as indicators of the Affective and SMs. The methodology employed is presented in the following section.

5 Methodology

The research presented in this paper aims to identify the recurring Undefined Socio-affective Scenarios, from LA in a VLE. Thus, a qualitative and quantitative approach was applied, such as multiple case studies, which, according to Yin [17], allow for comparisons of a contemporary phenomenon within context. The target audience included those in undergraduate, graduate, and extension courses offered at a Public University of Brazil. Thus, ten case studies were carried out that made it possible to apply LA and meet the research objective.

In this context, data collection took place from the interaction and technological production in ROODA, during the period from first semester of 2019 to first semester of 2020 in ten teaching activities (eight subjects and five courses) totaling 285 students, according to Table 1.

Table 1. Mapping case studies

Case Study	Learning Activity	Modality	Period	Number of Weeks	Number of Students
1	Graduate A	Hybrid	1st semester 2019	17	16
2	Graduate B	In person class	1st semester 2019	17	16
3	Graduate A	Hybrid	2nd semester 2019	17	10
4	Graduate B	In person class	2nd semester 2019	17	21
5	Graduate A	Distance Education	1st semester 2020	16	14
6	Graduate C	Distance Education	1st semester 2020	15	15
7	Undergraduate A	Distance Education	1st semester 2020	16	23
8	Undergraduate B	Distance Education	1st semester 2020	15	6
9	Course A	Distance Education	1st semester 2020	6	27
10	Course B	Distance Education	1st semester 2020	17	48
11	Course C	Distance Education	1st semester 2020	6	38
12	Course D	Distance Education	1st semester 2020	18	33
13	Course E	Distance Education	1st semester 2020	7	18
Total students					285

The undergraduate and graduate courses were offered at a Brazilian Public University between 2019 and 2020, 121 students participated. The DE courses took place in 2020; a total of 164 subjects (81 elderly and 83 professors) had their data analyzed. It is important to mention that, in the first semester of 2020, it was possible to carry out 9 case studies due to the COVID-19 pandemic, which extended the school term to the whole year.

Only the students' activities were analyzed, but the professors' teaching activities were not. There were no instructions for the teachers, they taught their classes as they had previously been planned. The researchers accessed the student data and mapped the scenarios.

Thus, from the analysis of the 13 case studies, a spreadsheet was created to identify the scenarios that arose in the AM and the SM. It then became possible to map the Socio-affective Scenarios of the students and the class. Finally, the spreadsheet was refined by accounting for recurrences. Hence, 56 Socio-affective Scenarios were created. Scenarios that did not contemplate the social and affective indicators that were identified were labeled as Undefined. Subsequently, the Undefined Scenarios were selected because they were those that appeared the greatest number of times in the 13 case studies. Thus, an analysis of the Undefined Scenarios was carried out in order to understand why most students were in this category and to, therefore, build PSs capable of intervening in these cases.

Based on these considerations, the next section presents the results obtained.

6 Results

It should be noted that a student can only be present in one affective indicator in a given week. Within this period, based on variations in mood that do occur, the students' position in the AM is determined. On the other hand, the student can be in more than one social indicator during a week, because the quantity of interactions is counted by counting the exchange of messages, as well as the frequency, sending, and sharing of files. Thus, if the student performs more than one action in ROODA, he or she may have more than one indicator.

However, in the mapping between social and affective indicators, 56 Socio-affective Scenarios were identified, yet 18 of them had none of the indicators (social or affective) that were analyzed in this study. Thus, the objective of this work is to identify the Undefined Scenarios, whether social or affective, as well as to create PS for these Scenarios.

Undefined Affective and Undefined Social Scenarios were created specifically for this purpose. Undefined Affective corresponds to the subject that is not present in any of the four quadrants (Animated, Discouraged, Satisfied, and Dissatisfied) in a given week. The reasons found for the student not being identified in any of the four moods were: the teacher's pedagogical practice did not request the use of the tools that extract data for the generation of the AM (chat, logbook, and forum) or they did not use these tools that week, thus making it impossible to determine students' affective indicators. On the other hand, Undefined Social refers to the individual who, despite being present in the VLE, did not report Feeling separated from the class or Drop out. However, this student nonetheless did not appear in any other social indicator: the student was not collaborative, did not belong to any informal group, and was not popular. This can occur when the student enters the VLE and does not write using any of the communication tools or has minimal participation, not allowing for collection or categorization of any of the indicators. The "Undefined Affective" Scenario is in the AM; therefore, it was simply readapted for the context of this research.

The result of the mapping between the affective and social indicators was organized in order to present the Scenarios that were found in this research, as can be seen in Table 2. The first column names the combinations, abbreviated by the letter "S" and a sequential number. The second column is composed of the affective indicators, being: Undefined Affective, Animated, Satisfied, Dissatisfied, and Discouraged. The third is composed of the social indicators and the creation of the Undefined Social. Finally, in the last column are the number of times that each Scenario appeared in the 13 case studies analyzed.

Table 2. Mapping socio-affective scenarios

Socio-Affective Scenario	Affective Indicator	Social Indicator			Number of Times
S1	Undefined Affective	Absence	–	–	715
S2	Undefined Affective	Collaboration	–	–	264
S3	Undefined Affective	Feeling separated from the class	–	–	5
S4	Undefined Affective	Drop out	–	–	364
S5	Undefined Affective	Popularity	–	–	8
S6	Undefined Affective	Undefined Social	–	–	1011
S7	Undefined Affective	Absence	Collaboration	–	229
S8	Undefined Affective	Absence	Informal Groups	–	1
S9	Undefined Affective	Collaboration	Feeling separated from the class	–	7
S10	Undefined Affective	Collaboration	Informal Groups	–	1
S11	Undefined Affective	Collaboration	Popularity	–	19
S12	Undefined Affective	Informal Groups	Popularity	–	14
S13	Undefined Affective	Absence	Collaboration	Informal Groups	1
S14	Undefined Affective	Collaboration	Informal Groups	Popularity	26
S15	Satisfied	Undefined Social	–	–	129
S16	Animated	Undefined Social	–	–	124
S17	Discouraged	Undefined Social	–	–	42
S18	Dissatisfied	Undefined Social	–	–	16

An analysis of Table 2 shows that three combinations frequently occur. They are: "Undefined Affective and Undefined Social" (n = 1011), "Undefined Affective and Absence" (n = 715), and "Undefined Affective and Drop out" (n = 364). Thus, the importance of creating these two new indicators stands out, since the Scenario with the highest recurrence was precisely "Undefined Affective and Undefined Social." It is important to highlight that the identification of "Undefined," both social and affective, is fundamental for these subjects and their particular interactions to be included in the VLE.

Therefore, based on the 18 mapped Scenarios, a PS was created for each of the six features in the ROODA VLE (chat, library, contacts, logbook, forum, and web portfolio), for a total of 84 PSs. These were constructed by a group composed of 15 professors specialized in DE with graduate training and experience in ROODA. It was also developed using the criteria established by Barvinski et al. [16], in order for the PS to be considered adequate in terms of structure, language, and direction of actions.

The creation process required 8 weeks of work, starting on 06/22/2021 and ending on 08/10/2021. During this period, 5 meetings took place in a synchronous video conference platform, in which the participants brought doubts, questions, observations, and reports about the strategies. The 108 PSs were divided among the 15 professors, totaling 7 for each, with one of the specialists contributing 3 more due to arithmetic issues related to the division of the tasks among the team members.

An online spreadsheet was made available, shared in edit mode with all participants. It contained 7 columns, as follows:

Description of the indicator: In this field, the meaning of the indicator was written, for example: "This indicator refers to the student with a very specific profile, since it was not possible to identify his mood in the VLE, that is, they are neither Animated nor Discouraged, neither Satisfied nor Dissatisfied."

Variables: Correspond to the features, which are: chat, library, contacts, logbook, forum, and web portfolio.

If (affective indicator) and (social indicator) and (feature) and (age value): This column contained the conditional "if" command, called "proposition logic" or "if then," which is a truth table, in which combinations were created. In the case of the first strategy, this field looked as follows: If (Undefined Affective) and (Absence) and (chat) and (A≤59), then strategy UAAc1 is recommended.

Identifier PS: This is the abbreviation of the initials of the affective indicator, social indicator, feature, and strategy number, for example: Undefined Affective, Absence, chat, and strategy number 1, thus: UAAc1.

PS based on the Socio-affective Scenario: This field should be filled in by the specialist with the description of the PS.

Name: In this column, each person put their name based on the PS they wanted to develop.

Status: This space was for the professor to fill in the status of the strategy—for example, they could put "ok" if it was finished or "to do" if it was not ready. After the spreadsheet was made available, the participants developed the PSs individually based on the Socio-affective Scenarios. Each expert was responsible for developing their total number of strategies, which dispensed with the need to establish weekly production goals or corresponding follow-up.

Table 3 shows examples of the PSs that were created for the "Undefined Affective and Undefined Social" Scenario.

Table 3. Pedagogical strategies created for the undefined affective and undefined social scenario

If (Undefined Affective) and (Undefined Social) and (chat) and (A≤59), then strategy UAUSc6 is recommended. The student has an Undefined Affective status and Undefined Social interactions. In the first case, the student shows neither (in)satisfaction or animation or lack thereof and also does not interact in the VLE. The lack, or low social interaction, was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify their mood or social indicator. Therefore, it is important that the student is contacted to analyze what difficulties and challenges they are facing. The chat feature enables synchronous communication and sharing of materials. Therefore, you can contact the subject through chat and encourage them to participate in the VLE. You can also ask them about their perceptions of the assignments, the teaching activity, the difficulties as well as the challenges they have faced. Positive feedback to this student can make them feel closer to you and more comfortable sharing their feelings. Hence, it is also important to evaluate the process and make changes if you consider them to be necessary.
If (Undefined Affective) and (Undefined Social) and (library) and (A≤59), then strategy UAUSl6 is recommended. The student has an Undefined Affective status and social interactions. They show neither (in)satisfaction, animation, or lack thereof and also have not interacted in the VLE. The lack or low social interaction was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify the mood or social indicator of this student. Therefore, it is important that you contact them and analyze what difficulties and challenges they are facing. The library feature allows you to publish, organize materials, and links as well as interact through comments. Hence, send a message through contacts to ask the student to select a video about the topic you are working on and post it in the library. Then, make a comment about the video ending with a question. The idea is that you create a way to contact the subject and in this first communication also ask them to share the link of this video through contacts with the class and to write how they felt doing this activity in their logbook. The goal is that, after the initial exchange with this student, it is possible to identify their mood and social interaction. This is a very interesting and challenging strategy; however, it is pertinent that you do a self-evaluation about your role and the importance of the words used during the process, since an incorrect mediation can lead the student to give up and even drop out of the class.
If (Undefined Affective) and (Undefined Social) and (contacts) and (A≤59), then strategy UAUSco6 is recommended. The student has an Undefined Affective status and social interactions. The subject shows neither (in)satisfaction, animation, or lack thereof and also does not interact in the VLE. The lack, or low social interaction, was one of the aggravating factors that interfered in the affective and social data of this subject. Due to the lack of messages sent and received in the environment, it was not possible to identify their mood or social indicator. Therefore, it is important that you contact this student and analyze what difficulties and challenges they are facing. The contacts feature allows you to directly approach this student. You can send a private message, encouraging them to interact and highlight the importance of this contribution to their learning process and to the teaching and learning process of the class. In addition, you can ask the subject to send messages to their classmates on general topics. Next, encourage them to write in their logbook about how they felt about the proposed activity. The goal is to identify their mood and social interaction. Thus, it is important that you carry out a self-evaluation of the strategy applied, in order to analyze if it is adequate for the student's profile and context.

The same process occurred for all 108 PSs based on the Socio-affective Scenarios, which are available at the link: https://drive.google.com/file/d/1KerUrh7MsZMOXchD_XU3nyl5tmj_hxI/view?usp=sharing. The PSs are in Brazilian Portuguese, because this study was applied specifically in this country.

Therefore, the Socio-affective Scenarios found may or may not be repeated in other situations, depending on pedagogical practices, the communication tools adopted, and the student's profile. The main contribution of this work is to point out the existence of certain Scenarios that can be inferred and PS that can be applied. From this information, professors can decide how to act, when trying to intervene in a Scenario such as Undefined Affect and Drop out.

7 Conclusions

In DE, the physical distance between the actors in the educational process makes their relationships unique. Therefore, the ways of knowing the other, communicating, and acting in a VLE are elements of analysis for the continuous qualification of this teaching modality. Thus, given its particularities, it is also necessary to consider the relevance social and affective processes play in learning. It is also necessary to develop analytical tools to give the VLE new resources that have the potential to promote pedagogical practices that are more sensitive to the DE paradigm.

Hence, it is advantageous for the professor to master these new tools and understand the student's socio-affective profile. By meeting their individual interests and needs, the goal is to contribute with the provision of subsidies for professor to reflect on their actions in teaching and learning processes and in decision-making.

In this study, 18 Socio-affective Scenarios were identified and 108 PSs were created, which are available for manual use by professors. Future research possibilities are related to the development of tools that analyze each student and automatically recommend PS. Thus, we intend to support interactions and professor mediations in VLEs as well as to contribute to the process of teaching and learning in DE.

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Corporate Digital Literacy Mandates: Using SDT-Based Strategies to Circumvent "Quiet Quitting" Syndrome

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Abstract—Envision an employee showing up faithfully every day for work but cognitively checked out every minute (i.e., quiet quitting). This article adapts a futurist perspective to describe the adult education pedagogy of experiential learning in juxtaposition to the limitations of behaviorist employee training incentives. The authors conceptually apply Spiral Dynamic Theory-based (SDT-based) predictive strategies to capitalize on the assumptions of intrinsic and extrinsic motivation themes among contemporary adult workers. The field of Adult and Continuing Education caters its teaching and learning to people who are 25 years of age and older. As employees, they bring to the corporate work environment a unique set of skills and life experiences that require pedagogical delivery that is innovative and motivating. Research shows that older adults are often technology averse. Therefore, scaffolding the employee's use of technology and social media as expectations of the work tasks could help improve low digital literacy and increase self-efficacy. This paper offers SDT as an instrument for adult training and professional development design.

Keywords—affective experiential learning, behaviorism, corporate social media, quiet quitting, Spiral Dynamic Theory

1 Introduction

Learning environments and concepts are integrally connected to how adults engage and problem-solve within social contexts and organizations. Marsick and Watkins [1] emphasize the importance of innovation-and-organizational knowledge perspectives that give attention to how adults store, retrieve, and manage knowledge by "finding ways to harvest the tacit knowledge embedded in routines and processes." Hence, learning organizations made up of individuals are "socially created"; these collections of people work together, playing a primary role in changing how they respond to challenges within and outside of any institution [2]. Learning for adults also includes the cultural perspectives that position them to utilize organic processes to make meaning as they co-create knowledge. By introducing the concept of culture, we can more deeply examine how it informs, facilitates, or impedes learning and team building. Deep analysis of technology's role in learning organizations alongside the convergence of

changing demographics requires optimal approaches and strategies for adult learners and their psychosocial development [3].

1.1 Reimagining concepts in adult learning

This article explores the authors' interpretative experiences relative to the role of traditional adult learning philosophical perspectives and theories to juxtaposition them to contemporary human resource development conditions using the Spiral Dynamic Theory (SDT) framework. We engage with the concept of complexity and diversity as we operationalize *affective*[1] collaboration strategies for teams of adult learners, taking into consideration the developmental change that occurs in the process. We privilege the social context of delivering online learning in this discussion, focusing on teaching, and how the experience evolves in the corporate workspace [4]. The examination of how adult educators use innovation in their delivery of pedagogy and praxis while considering how autonomy (self-directed learning) and collaboration are essential methods for team and group work [5, 6] among adults is discussed. Additionally, we recognize that the inclusion of *life experience* and embodied ways of knowing have increasingly become critical aspects of how adults want to learn in innovative ways [7].

Crentsil, Gschwandtner, and Wahhaj [8] provide valuable insight into how technology aversion among adults might be overcome when examining its impact on small-scale farmers who were more influenced by issues of ambiguity associated with risk-taking in their use of technology. The ambiguity relative to new farming processes became a primary variable that inhibited Ghanaian farmers from adopting innovative technologies. This suggests that cognitively meeting adults at their level of complexity relative to problem-solving is crucial for integrating technology into their daily life and work.

Piaget [9] developed a stage theory to provide models for cognitive development—primarily among children—finding that as one matures, new capacities for problem-solving and knowledge acquisition allow for more complex and accurate real worldviews. However, the final stage of his theory, formal operational thinking, served as the beginning of adult thinking. Neo-Piagetian paradigms [10] built upon the concept of formal operational thinking, leading to a more emergent understanding of adults' thinking and developmental problem-solving over time. In making a case for what Piaget believed, von Glasersfeld [11] describes the theorist's model of human existence as that of *Radical Constructivism*. The neo-Piagetian held that Piaget's theory of knowledge required a reorganization of ideas about knowledge stating:

> It is not a question of merely adjusting a definition here and there or rearranging familiar concepts in a somewhat novel fashion. The change that is required is of a far more drastic nature. It involves the demolition of our everyday conception of reality and, thus, of everything explicitly or implicitly based on naïve realism; it shakes the very foundations on which 19th-century science and most 20th-century psychology have been built [11].

[1] *Affective* collaboration and strategies, for our purposes, involve moods, feelings, and attitudes that can emerge during team/group student work due to the diverse SDT ontological worldview(s) of the adult learner(s) and the social context that locates the graduate-level education.

Adult learning and development scholarship identify linkages between how well adults can navigate complexity and ambiguity using models of hierarchical cognitive thinking [3, 12, 13, 14, 15]. Moreover, the evidence suggests that dynamic changes in the ability to problem-solve among adults require a forward change in their psychosocial realities [16, 17]. This change results from meeting particular conditions (Table 1) that lead to higher-order thinking and consolidation of SDT worldview(s) change.

1.2 Spiral dynamic theory

The theoretical framework guiding our discussion and this conceptual article is based upon the idea of expanding levels of human existence—termed SDT—that direct the thinking and problem-solving capabilities among individual adults, organizations, and larger societies [16]. We use this knowledge to inform our delivery of adult learning pedagogy to groups and collaborative teams.

SDT has its origins in the scholarship of Clare W. Graves [15, 17, 18]—a psychologist and Professor Emeritus—who retired in 1978 from Union College in New York. Graves initially described the theory advanced as his Emergent Cyclical Level of Existence Theory (ECLET), grounded in his interdisciplinary research that bridged the adult biopsychosocial systems disciplines at Union College. Graves contended that adult learning and development was an open-ended system of emergent thinking and evolving worldview constructs [13, 15, 18]. However, he was initially discouraged about the ECLET due to witnessing a colleague (Abraham Maslow) being *torn to pieces* about his theory on the hierarchy of human needs due to underdeveloped data at an APA seminar in the 1950s [18]. Graves vowed he would never subject himself to such humiliation and have his research be strongly maligned in the field due to weak empiricism. Hence, he retained several incomplete manuscripts until he died in 1986. Therefore, Grave's scholarship was not as highly published and implemented until it was taken up and shepherded by his protégés in the late 20th century [16]. Nevertheless, Graves [18] used the rejection experienced by Maslow to fine-tune his theory. He later goes on to state that:

> Maslow came around to my point of view. If you look at some of his later writings, you will see that he accepted both the cyclical idea that there are more than one kind of expressive system and more than one kind of belonging system and that the systems were open-ended [19].

As Grave's protégés Don Beck and Chris Cowan continued to advance his scholarship—the latter of whom mentored and trained one of the authors of this article in the use and application of SDT—Brown [13, 20] has refined several of the worldview constructs. The resulting evolution of the prior frameworks helps make the application of the emergent model (offered in this presentation) useful in examining adults' thinking and values-based responses in connection to cultural diversity [65] and even more specifically, work environments.

Table 1. Six stages are required for SDT worldview level movement

The Chronological SDT Change States	Conditions Needed for Problem Resolution
1. Change Potential (Open/Closed)	The change potential for the adult must be met through the acquisition of new insights. Some adults will remain resistant to change, becoming static in their ability to problem-solve or advance in ontological reality.
2. Solutions	The problem is recognized cognitively, and an understanding of the need to address the problem is made clear.
3. Dissonance	The disturbance generated by the solution stage subsequently triggers a regressive movement in how to solve the problem.
4. Insight	New clarity and insight are introduced into the thinking about the problem that halts the regression movement as strong enlightenment points that facilitate change are realized.
5. Barriers are removed or neutralized	Non-interference for the change to occur or properly timed aid is provided to the adult leading to assistance with overcoming the problem.
6. Consummation of change	The adult experiences an SDT worldview level jump to consolidate the change in thinking and resolve the problem.

Note: During the consummation of change (Step 6), quantum leaps can occur in the SDT worldview typologies stages, disrupting the normal progression of change and problem-solving ability. However, such leaps are very unstable and typically result in a regression downward to a more optimal SDT worldview level change stage [12, 18].

Memes the transferable units of culture. Although Clare W. Graves [18] never explicitly used the term *meme*, a unit of culture that transfers from person to person through non-genetic human imitation [21], his conceptualization of the term was present in his research on how thinking and problem-solving capacities evolved from one stage (worldview construct) to the next on the ECLET spiraling framework. His protégés later advanced the theory of the movement up the framework as a dynamic spiral of value memes (i.e., ^{v}MEME[2]) of increasing cognitive complexity [16]. Additionally, movement along the framework is induced by problem resolution, as shown in Table 1.

Hierarchical and evolving worldview constructs. Brown [3, 20] provides some descriptive details about the unique worldview constructs that exist in the framework. The diagram (Figure 1) uses a mnemonically color-coded system to distinguish each worldview construct that begins with low-order simplistic thinking and then progresses upward in a zig-zag fashion toward more complex taxonomies of higher-order thinking and problem-solving abilities.

The adult learners to whom we deliver the SDT training and professional development are provided with initial in-session orientations to become familiar with

[2] ^{v}MEME(s) represent ontological Spiral Dynamics organizing principles and values embedded within a taxonomy of emergent worldviews and hierarchical cognitive problem-solving abilities. The ^{v}MEME is mimetically influenced and therefore functions as a type of meta-meme within the SDT framework [13].

SDT and its taxonomy. Then they are asked to self-assess their positionality on the SDT framework using case study scenario exercises to guide their evaluations. Throughout the sessions, the instructor makes continuous nonformal assessments by observing the trainees as individuals and in their group collaborations. The assessment tools and strategies assist the session facilitator to identify optimal project team grouping recommendations that align with the emergent SDT model.

The horizontal worldview constructs (Figure 1) experience the most conflict while the thinking among the immediately vertical neighboring system tends to maintain the most harmonious collaborations. The following descriptions are associated with each of the color-coded ᵛMEME with conceptions of teal and coral currently at the hypothesis stage of investigation:

Basic instinctive. The beige A/N coded *value meme* system is representative of a precultural existence. Wherein the case of the individual, he would possess low self-awareness. The thinking is driven by physiological imperatives and the simple purpose of staying alive [13, 22]. The locus of control is internal, and the thematic orientation is individualistic.

Magical mystical world. The purple B/O coded *value meme* system is concerned with safety and security through kinship ties. This worldview system believes in obeying the desires of magical-mystical spiritual beings and divine authority figures (e.g., priests, Shamans, tribal elders). The purple-coded is marked by fantastical thinking, tribalism, and traditionalism. The locus of control is external, and the thematic orientation is collectivist.

Power impulsive. The red C/P coded *value meme* system is the egocentric memetic worldview often marked by imperatives of domination by force and intimidation. It is represented by thinking and actions that are impulsive. The perception in thinking holds that life is a jungle where there exist the haves and the have-nots. The driving force is to be among the haves. The locus of control is internal and individualistic.

SDT Constructivist Theoretical Framework Model

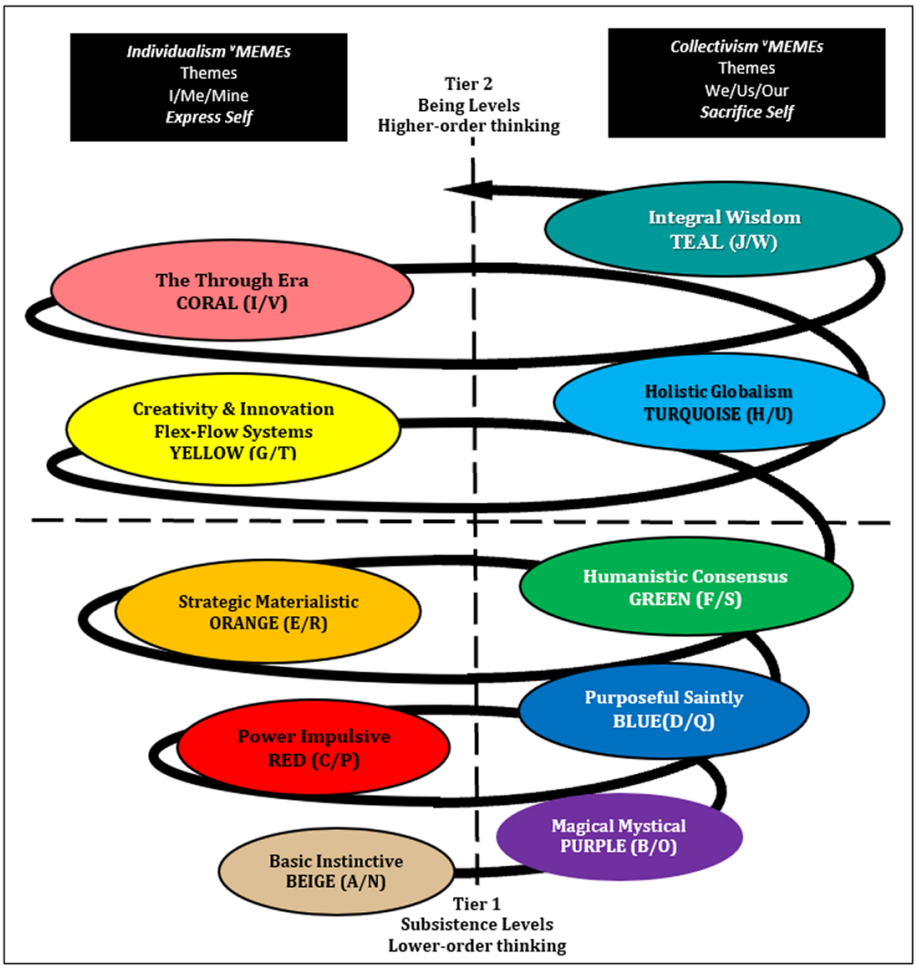

Fig. 1. This figure displays the oscillating zig-zag movement up the spiral representing the changes in SDT worldview constructs, thinking, and problem-solving abilities (reproduced with permission [3]

Purposeful and saintly living. The blue D/Q coded *value meme* system represents honor and a good versus evil memetic worldview. This thinking believes that we are assigned to a specific place in life and must accept our lots in life as predestined. This thinking can be marked by dogmatic absolutism where calls for sacrifice are urged to bring order and stability to a chaotic space. The thinking can be paternalistic and authoritarian with goals for obtaining the betterment of everyone. Rules are to be followed and are often non-negotiable. The locus of control is external and collectivist.

Strategic materialism. The orange E/R coded *value meme* system is marked by manipulation and a memetic worldview that values autonomy and independence. Winning and competition are prevailing values of this system. Using scheming tactics

and cunning strategies to obtain desired outcomes is a driving force. Gaining high achievements that bring praise and material possessions is viewed as the most optimal reward. The thinking is grounded in logic and a reasonable calculated certainty for success. The locus of control is internal and individualistic.

Humanistic consensus. The green F/S coded *value meme* system F/S is the relativistic memetic worldview that believes in human dignity and consensus building in contrast to religious edicts. There is an effort to explore the personal *inner self* in cooperation with the inner self-discovery also being made by others. The thinking in this value meme system prioritizes the life of community, unity, and harmony, as the group seeks to share societal resources for the benefit of all. The locus of control is external and collectivist.

Creativity & innovation/flex-flow systems. The yellow G/T coded *value meme* system represents the first of the more complexity-oriented constructs (i.e., Tier 2 worldviews). In the literature, the yellow value meme represents a departure from the preoccupations of subsistence living found with the Tier 1 constructed thinking. Yellow marks the first worldview of Tier 2 *being levels* where the problems of subsistence living are clearly understood even though they are not necessarily under control [1, 13]. The SDT yellow value meme thinking welcomes paradoxes and uncertainty. It accepts a flex-flow [13, 20] perspective that appreciates the layered dimensions of human nature and societies. The locus of control is internal and individualistic.

Holistic globalism dichotomies. The turquoise H/U coded *value meme* thinking represents the second of the Tier 2 constructs. This system reflects the globalism memetic worldview marked by its ability to more easily negotiate complexity and recognize patterns more immediately than seen operating under the prior lower six, Tier 1 ^{v}MEMEs. Its priorities include the pursuit of the good for all living things, and the thinking views the world as a single dynamic organism possessing its own type of independent human energy of *mind.* Turquoise thinking is more driven by purpose versus achieving harmony with other persons. The locus of control is external and collectivist.

The through era. The coral I/V coded *value meme* system reflects the worldview that privileges the use of perspectives that merge human biology and technology, thinking it to be the most optimal approach to adult existence. At this level, adults have advanced in their problem-solving abilities as they are no longer burdened by subsistence living. As a result, there is a freeing up of the capacity for higher-order thinking to engage more complex problems of the human condition. This construct is among the last two value meme constructs currently included in the [12] SDT model and is in developing formulation. The research limitation for the Coral and Teal constructs is constrained due to the impediments for the author to secure access to a sufficient sample of individuals holding to these types of adult thinking patterns. Coral thinking represents "a secular vision of unlimited technoscientific progress" where notions of God and faith are integral [22]. The locus of control is internal and individualistic.

Integral wisdom and human insight. Like the prior coral I/V coded *value meme* system, the teal J/W coded value meme system represents a construction based upon theoretical propositions by the author using interpretive observational pilot research and adult development literature [23, 24]. Note that at the Tier 2 level of the SDT framework, the differences between collectivist orientations juxtaposition

individualistic worldview orientations begin to become less pronounced. The tensions and disagreements between the horizontal conflict patterns among the adults engaged in Tier 1 level thinking led to more significant stagnation concerning problem-solving between diametrically oppositional perspectives [13, 16]. However, the Tier 2 teal J/W system departs more gently from the prior coral systems of adult thinking introducing a more tempered reliance on technology and mechanization to resolve complex human problems. The locus of control is external and collectivist.

2 Review of the adult learning literature

Constructivism theory views learning as constructing new knowledge that includes social, cultural, and experiential components with early roots dating back to Socrates and his teaching method of allowing his followers to challenge their ideas [25]. Jean Piaget is attributed with developing the modern theory of Constructivism; however, many well-known contributors, such as John Dewey, Lev Vygotsky, and Seymour Papert, have also informed the theory's development. Constructivism purports that learners interpret new information through personal, contextual lenses and build upon existing knowledge and previous experiences to construct a new understanding of their world [26]. Constructivism centers on the learner's characteristics of self-direction and experience to create new knowledge. It reflects real-life problem-solving and supports the general principles of adult education and lifelong learning [27, 28].

2.1 Experiential learning

As mentioned, Constructivism involves a synthesis of multiple theorists from Dewey [29] to Piaget [9] and Vygotsky [30], who profoundly affected Kolb's [31] Experiential Learning theory. The latter theory emphasizes the significance of experience in the adult learning process, and it views learning as a more holistic and integrated process that combines experience, perception, cognition, and behavior [32]. Experiential Learning is the construction of knowledge and meaning from real-life incidents or simply learning by doing and undergirded by individual reflection [33].

Experiential Learning fosters new neurological connections in the brain, thus helping adults learn new things [34]. Brown [13], as an element of the SDT framework, advances the concept of transferable *mental units* of culture termed *memes*. She goes on to recognize that in the field of adult education, there is a "Growing body of knowledge on adult development and how cognition—that can be dynamic and evolving—contributes to the adults' problem-solving capacities and their abilities to negotiate environmentally complex social contexts and thinking" [13, p. 206].

Therefore, the role of experience and neuroplasticity[3] can operate as key variables for examining how adults learn and develop. SDT offers an interpretive model for how adult learners engage in adaptive complex critical thinking in new and innovative ways based on the connections formed (or uncoupling) that occur during group collaborations.

[3] A general umbrella term that refers to the brain's ability to modify, change, and adapt both structure and function throughout life and in response to experience.

Nevertheless, Schenck and Cruickshank [35] offer criticism of the Kolb [31] model due to its cyclical nature and its inability to adapt to newer research. We advance that SDT introduces a contemporary lens of epistemology that bridges the need for a newer way to examine adult learning using an integral view of the body, mind, and spiritual ways of knowing within dynamically changing social contexts [3, 20].

3 Social media in the corporate environment

The use of social media and digital technology has left an indelible mark on adult learning environments in our society, with both positive and negative outcomes [36]. The employee educational strategy for corporations has pivoted away from traditional lecture-oriented approaches to digitally based knowledge delivery [37]. Leading the way in adult learning innovation are social media informal learning formats heavily influenced by the corporation's social media strategy. Corporate educators have adopted the principles of social learning to improve collaborative learning, increase learner flexibility, and reduce costs by using standardized web-based learning environments such as *Twitter* and *Instagram* [38].

Many organizations recognize the potential of digital literacy for its rapid access to consumers and leverage their employees in their social media strategy [37, 39]. This plan of action allows employees to increase brand knowledge and connections with potential customers hence becoming key market influencers. Therefore, through directives from upper leadership, a company policy may require employees to express positive messages through social tweets and posts on behalf of the organization. Such actions can serve to positively influence brand awareness and improve market reach at minimum costs [39, 40, 41].

However, the personal characteristics normatively associated with adult learners, such as self-directedness, self-efficacy, adapting to new social contexts, personal autonomy [42], and the application of lived experience in creating new knowledge by employees, may be absent. Approaches to injecting social media as a work requirement may risk producing the opposite effect of positive branding when behaviorist tasks reduce affective learning and enthusiasm among workers [43]. Therefore, corporations must be mindful in their attempts to infuse employee social media skills and usage into the organizational culture [25, 36].

3.1 Case study

In this case analysis, a multinational technology company positioned *digital brand ambassadorships* as a way for employees to increase collaboration with customers and colleagues. The learning strategy was an opportunity to improve the worker's social skills. It also served to enhance digital identity and increase brand awareness online. The company used a behavioralist approach in implementing the initiative, requiring brand ambassadors to 1) tweet multiple times weekly, 2) participate in *LinkedIn* discussions, and 3) post on *Instagram*. The employees who served in leadership roles were assigned the titles of *Brand Ambassador* and were responsible for their departments or functional groups. A measurement tool was used to track employee social media participation

and a departmental scorecard was published for senior management and departmental leadership to inspect every Monday. The monitoring tool also provided statistical data used in the employee evaluation process.

The company provided each employee access to a multi-dimensional digital application with pre-built tweets to support the initiative and facilitate process efficiency. The application offered various categories of content that included organizational updates, product launches, upcoming tradeshows and conferences, executive blogs and briefs, and philanthropic events. However, employees still needed to acquire a baseline knowledge of social skills and practices not directly supported by a formal learning program offered by the company as part of the initiative's launch. The employees who served in leadership roles were assigned the titles of *Brand Ambassador* and were responsible for their departments' participation. Most employees acquired basic skills through informal learning channels such as viewing online tutorials on *YouTube*, colleague mentoring, and on-the-job independent practice.

Although the corporate marketing department developed limited training material, each department's responsibility was to ensure digital and social education among its employees to the obtaining of self-efficacy. Many older employees struggled with building digital proficiency at the pace needed to achieve their weekly posting quotas. This challenge created frustration and anxiety and thrust employees into a competitive environment instead of a collaborative, knowledge-sharing community [43]. The company missed the opportunity of integrating adult learning pedagogy into teaching employees how to effectively acquire and use social media skills to improve personal digital competency and expand interpersonal relationships in the workplace and in producing harmony with the emerging external online work context.

4 Behaviorist training approaches in professional development

Noted psychologist B. F. Skinner [44] is well-known for his contributions to the field of adult education through his advancing of the philosophical perspective of behaviorism. Practitioners whose professional concentration emphases are in the areas of Human Resource Development (HRD) are much acquainted with traditional practices that draw upon behaviorist pedagogy used for training and employee professional development [45]. As an academic exercise, and for the scope of this article, we examine behaviors and training that result from stimuli used to change the activities of workers through the reinforcement systems of incentivizing rewards and disincentivizing penalties if targets were not met within a newly implemented online corporate working environment for lower-level employees.

Skinner saw human action as being dependent on the consequences of previous actions, a theory he called the principle of reinforcement [46]. Under conditions of reinforcement, he theorized that, if the consequences of an action are negative, it is more likely that the action will not be repeated. Conversely, however, if the outcomes of actions taken by the subject are positive and perceived as good by the authority providing instruction about the new learning, the probability of the action being repeated becomes inevitable [47].

The behaviorist perspective also overlaps with the humanist adult education perspective [48] where the adult actor is centered within the learning experience. However, in the case of the former, behaviorist instruction is far less self-directed. Therefore, important elements of autonomy that are viewed as one of the key principles of adult education (i.e., andragogy) are less pronounced [49].

Nonetheless, Skinner further discusses the administrative difficulties encountered by those leading adult instruction. He goes on to describe the phenomenon of individual variances [50] and how adult educators might negotiate these differences. More specifically, Skinner makes the case for providing a supportive environment for the worker holding that positive reinforcement rather than negative reinforcement is the best way to influence adult behavior when teaching [51]. He also found it necessary to cope with individual variances most immediately among those adults where the objectives of effective learning or training were not being met [50]. Ideally, most workplace environments have been designed to promote specific employee behaviors, and employees must perform their tasks satisfactorily to receive rewards.

4.1 What is quiet quitting?

A generational difference is emerging among worker classes giving rise to a phenomenon known as *quiet quitting*, which was first used in an academic setting by economist Mark Boldger [52] at a Texas A&M economic symposium focused on Venezuela's waning ambitions among its worker class. A social media influencer name Zaiad Khan [53] made a Tik Tok video introducing the quiet quitting concept, and much like most socially constructed memes, the term became popular, causing it to go viral and spread like wildfire globally. In essence, quiet quitting is the concept of continuing to work but giving up the idea of going above and beyond the metrics of high work performance. The employee simply continues to fulfill assigned work-related tasks, but the worker has disengaged from notions of competition or ambitions for company advancement. The traditional symbols or other such on-the-job reward trinkets no longer serve as intrinsic forms of motivation [54] for the adult worker.

The employee simply is no longer adhering to the hustle attitude that so many of them had grown accustomed to believing by uncritically accepting memes that defined notions of what makes for positive work ethics. Under the concept of *quiet quitting*, the employee embraces the mentality that their worth as a person is not defined by their labor [55]. Moreover, people who have experienced a lack of loyalty from a company—when they work diligently for their employers but receive no loyalty in return—have little incentive to exceed requirements giving rise to the quiet quitting social phenomenon.

For example, if the national cost of living rate increases significantly but an employee receives a merit pay increase that is not in keeping with that inflation, then the employee may feel that they are not valued and succumb to the quiet quitting mindset. As an example, to avoid a more radical response—such as a general worker strike—during tenuous economic times, the employees operating under this social phenomenon simply reduce their production rather than terminate their employment. They have come to recognize that overworking themselves for promotions and incentive raises which are

likely not to materialize is untenable. As a result, workers negate and reject the *hustle culture*, in which their jobs dominate and take precedence over their lives.

Another example of quiet quitting is muting emails and notifications after work hours rather than working outside of the normal 9 a.m. to 5 p.m. workday. The employee is doing what they are paid to do and setting boundaries about work expectations versus when they are off work and exercising that they are within their right to be unwilling to do more or being exploited.

Now is the time for employers to effectively respond to this emerging trend. Corporate leaders must take on the role of behavioral engineer to methodically motivate and respond to organizational needs and change dynamics. Company leadership must be mindful of the importance of rewards and incentives necessary to achieve the desired output of productivity. Employee assessment tools are needed that monitor and gauge the risk of quiet quitting—before disincentivizing feelings of being undervalued are allowed to grow or become critical toward hampering long-term organizational success.

4.2 Benefits of affective adult learning theory

The authors contend that a well-organized plan using a constructivist adult education philosophical approach could have improved workplace collaboration, teamwork, and reduced employee anxiety caused by the social media initiative's launch in the case study. For example, by leveraging Kolb's [31] experiential learning theory in formal and informal adult education settings, employees could 1) engage in on-hand learning, 2) reflect on their experience, 3) build conceptual knowledge of the broader social media processes, and 4) incorporate new approaches to refine their learning and delivery activities [55]. Using a more constructivist approach guided by experiential learning with feedback loops would have allowed employees to value the benefits of using a social media platform and building digital literacy at a more individualized pace with greater flexibility.

Additionally, based on their organizational roles and responsibilities, there was an a priori taken-for-granted assumption that the social media *Brand Ambassadors* ranked high in the areas of self-directed learning. It was assumed that they could take responsibility for employees' autonomous learning due to their higher organizational status and help with their direct reports. However, a proper understanding and preparation of company leaders surrounding principles of adult self-directed learning theory could have provided an additional layer of support techniques for the ambassadors. For example, incorporating Grow's self-directed learning stages for interacting with the employees could better position leaders for proper evaluation of employee work performance developmentally in meeting company goals and objectives [25].

5 Long-term strategic planning

The use of social media in corporate environments will continue to expand, so the need for training and education will remain strong [36, 39]. As illustrated in the above company case study, adopting social media presents a complex learning curve for some employees—particularly for technology and social-media-adverse adult learners. Therefore, organizations would benefit from using adult learning pedagogy in worker

training to help capitalize on the life experiences of diverse adult learners and better understand how the newly acquired skills can benefit them professionally and personally via interacting with and sharing social content [38].

Social media platforms are well positioned as emerging tools to expand the modalities for corporate adult learning. They offer a venue for more novel and contemporary constructivist learning opportunities. For example, through enhanced human connection activities that leverage innovative social media tools, such as the voice capture platform of *Twitter Spaces*, the potential to harness increased engagement and high-quality informal adult learning is enhanced [56].

5.1 Ways of knowing and pragmatic collaboration

Adult Learning is expansive having a plethora of theories, modalities of pedagogy, and innovations for teaching and instructing adults. Hence, we hold that adult education and learning tend to be very organic, due in part to the role of life experience, and that learning generally is far more developed in humans than in any other living species [57]. Thus, the goal to sustain *affective* adult learning teams in employee training and professional development entails the coordination of human phenomena (e.g., moods, feelings, and attitudes) as we consider embodied ways of learning in online spaces [25].

Gallagher [58] describes an approach to meaning-making termed *enactivist* that involves mixing the brain and bodily processes. He held that cognition is not just in our minds but also in our bodies related to environmental factors. Therefore, enactivist interventions are designed to show that the mind is not exclusively in the head, nor would our responses to problem-solving be. SDT offers, per our proposal, an aperture to the mind-body domain to the complexity of adult learning.

Opposite to the approach of enactivist is pragmatism, which holds that the *truth* of beliefs, theories, or meaning-making happens via the practical success of their applications. SDT holds that beliefs are a part of our conscious and unconscious value systems. Thus, a practical application of a known truth (i.e., pragmatism) requires some level of predictability but does not necessarily offer prescriptive pathways for the adult learner when their practical truths are met by uncertainty or chaos. We suggest that the incongruence of knowledge and experience among employee collaborative teams could be mitigated by properly blending like-minded and diverse thinkers among working group teams [59].

Illeris [57] contends that four notable styles are associated with specific languages and geographical regions. They include the *Gestalt view*, *American behaviorism*, *Russian cultural-historical theory*, and *Piaget's Constructivism*. As technology has expanded from the late 20th century until the present, team dynamics have needed to evolve. Firstly, one must understand what elements comprise *affective* teams and group collaborations. According to Johnson and Johnson [6], a team is a kluge of interpersonal communications and actions molded to contend for an established goal. In formal adult learning contexts, students are often challenged to form various connections and schemes that lead to high-quality participation among team members. We hold that clear and informed application of the SDT levels, particularly those found in Tier 1, provides for conditions where one can see the scaffolding necessary to engage in problem-solving [13] that facilitates higher-order thinking among individual students and groups.

5.2 Managing diversity in online communities of practice

The literature provides evidence that *formal learning* is the pedagogical model that adults find most helpful in establishing policy assessments about access, curriculum preparation, resource management, and improvement of learning capabilities [60]. Moreover, adult learners in formal and nonformal settings tend to identify via socioeconomic, cultural, and lived experiences. Schugurensky and Myers [61] argue that lifelong learning is often centered on normative and ontological components. Hence, the potential for human disconnection via the overuse of innovative learning technologies, for the delivery of adult education can present emotional anxiety for educators and learners [62]. For example, in a virtual learning setting, some team members are more expressive, blunt, and free with their responses on discussion boards and chat rooms [6]. We suggest that an adequate preliminary evaluation and assessment of the individual employees' diverse worldviews can foster optimal innovation and *affective* team building using SDT to identify and foster sensory attributes [13, 65] that may match well between collaborators as they pursue mutually accepted corporate goals.

6 Conclusion

SDT interprets the individual, organization, and societal domains into an adult learning framework that demonstrates how behavior oscillates between dynamically changing worldviews [20]. Since technology is a crucial factor in each of these three domains, understanding its role in the lives of adult learners is important.

In the past, many technology-based learning programs emerged from a history of computer-based training aligned with behaviorism [63]. In today's adult learning environment, technology plays a crucial role in providing a learning framework for deeper personal learning while enabling real-world learning experiences through virtual environments [63].

We contend that a proper SDT assessment is necessary as a precursor for *affective* adult learning and development (diagnostic) or collaborative group formations. Assumptions that all learners' preferences for the delivery of pedagogy, technology, and organization/logistics [62] are valid concerns in adult education. Nonformal and emerging informal learning in local communities and online social media spaces—particularly during the COVID pandemic—have experienced our highest adult participant increases [64].

Adult learning principles maintain that adults learn best when they are allotted choices about their learning [42]. Our supposition and hypothesis to date hold that being able to collaborate well within teams and groups, for optimal adult learning to occur (especially when using innovative technologies), we intentionally include the *affective* dimensions of intercultural relations among diverse adult groups engage in corporate learning. Therefore, to curtail corporate economic losses due to maladaptive training that leads to worker attrition or the emergence of quiet quitting in the workplace environment, our recommendation would include the use of SDT-based assessments and strategies.

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A Conceptual Model for Meeting the Needs of Adult Learners in Distance Education and E-Learning

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Abstract—More than 40% of undergraduate students are 24 years of age or older [1], and over half of these students are enrolled in distance education [2]. However, adults do not fare as well as traditionally aged college students, who are four times as likely to graduate [3]. The workforce is both aging and becoming more age diverse, resulting in the need to provide ongoing training for a range of learners [4]. There is some evidence that training performance declines with age [5]. Understanding the needs of the adult learner in distance education and e-learning is important for improving their experience and outcomes. By combining cognitive, social, and emotional factors, while being sensitive to the impact of context, we can develop programming that meets the needs of the whole learner. Drawing from the science of learning, I will outline the components of my conceptual model for meeting the needs of adult learners in distance education and e-learning. There is a diverse body of evidence-based instructional practices to support each of the factors in this model, but additional research may show significant interaction effects that may be especially beneficial for adult learners in distance education and e-learning.

Keywords—adult learners, distance education, e-learning, learning sciences

1 Introduction

Increases in life expectancy, coupled with the financial need to continue to work past traditional retirement age, has led to an aging workforce where employees of different age groups are working together more than ever before [4]. Advances in occupational complexity has also contributed to more adults seeking postsecondary education, primarily through distance education [6, 7]. As learners, established adults have different characteristics and needs than children and young adults, and these needs impact their ability to learn. These include their prior knowledge and cognitive functioning, identity and social roles, affective factors, and life contexts.

Instruction for adult learners in distance education and e-learning needs to be more efficient and effective so that adult learners can meet course objectives without spending additional time that they generally do not have. Lee [8] reported that students often cite falling behind in their course work as a reason for dropping out of higher education. In their study of adult learner behaviors in distance education, Yin and Lim [9] found

that more than half of the students reported spending an average of at least 12 hours on completing an assignment, with nearly a third of adults spending more than 21 hours on each assignment. This is in addition to up to five hours a week of self-study that more than half of the adult learners spent on each class. The majority of students in this survey held full-time jobs in addition to their enrollment in higher education. For students who maintain several concurrent course enrollments to meet financial aid requirements, this can amount to a second full-time job. I question whether workload in college courses should be determined arbitrarily according to traditional notions of seat time or if assignments should be designed to maximize the limited time and cognitive capacity that adults have available to learn.

In organizational training and development, e-learning is a common means used for training employees on job-related knowledge and skills. However, adults over age 40 reported that e-learning was their least preferred learning modality [10]. These negative attitudes towards e-learning can have a direct impact on the effectiveness and transfer of this training in the workplace [11]. In this paper, I will describe salient characteristics of adult learners, argue for the importance of the study of this population, and outline a model of factors from the learning sciences that should be considered in meeting the needs of these learners in distance education and e-learning.

2 Characteristics of adult learners

In addition to the financial, personal, and family challenges that adults juggle, adding student identity into the mix poses additional challenges [12–14]. The mental load imposed by these other responsibilities follow them throughout the day, limiting available working memory for learning. Rather than focusing their identity on being a student, as is the case for many traditionally aged college students, adults often incorporate "student" as one of their many identities into their already complex lives [13, 15]. Often, their engagement in higher education follows a life crisis, adding to the emotional burden of developing a new student identity [15]. Socioemotional selectivity theory suggests that when time is perceived as limited, emotional goals take precedence; however, when time is perceived as unlimited, goals are more likely to be preparatory and information based [16]. Therefore, motivations for learning change throughout the lifespan, resulting in different approaches to learning opportunities by adult learners.

There are several changes in cognition throughout the lifespan that are relevant to learning, including processing, brain structure, and memory. While many developmental changes in the brain are linear, some follow different trajectories [17, 18]. Generally, crystallized intelligence, or depth of knowledge and wisdom, is maintained or increased throughout the lifespan, and fluid intelligence, or reasoning and inference that does not rely on background knowledge, begins to decline after adolescence (see Figure 1) [17, 19, 20]. These have also been referred to as cognitive mechanics, or the capacity of the neurophysiological architecture of the brain, and cognitive pragmatics, or the content-based, culturally shaped aspect of intelligence [21, 22]. Pragmatics, including knowledge and learning strategies, can be a benefit to adult learners, while decreases in mechanics can inhibit learning. Designing instruction to maximize the use of cognitive

pragmatics and minimize the dependence on cognitive mechanics can be beneficial for adult learners. It should be noted that there is wide variability in cognitive functioning of adults, and some of this is culturally mediated. While there is some commonality in brain functioning patterns throughout the lifespan, it is important to understand learner variability to optimize instruction [23, 24]. The Learner Variability Project from Digital Promise can be a useful resource in understanding and planning for this variability (https://lvp.digitalpromiseglobal.org/content-area/adult-learner).

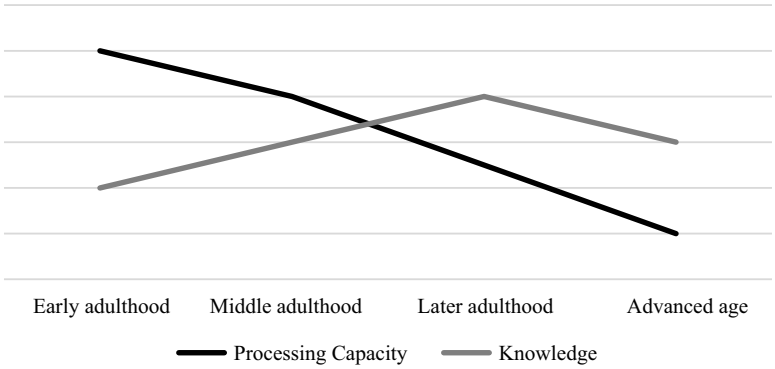

Fig. 1. Approximate trajectories of processing speed and knowledge levels throughout the lifespan [19, 20, 25]

The ability to quickly manipulate and integrate information and efficiently switch tasks peaks in adolescence and slowly declines throughout adulthood [17, 26]. More specifically, working memory performance begins to suffer in middle age, but adults recruit different and additional neural networks to complete tasks than children and adolescents, suggesting that their brains are adapting to the situation but that this may require more effort [26]. Some of these changes may be due to changes in brain structure. For example, myelination of neurons, which increases efficiency of signaling, continues throughout childhood in several areas of the brain and is not completed in the frontal cortex, where higher order thinking occurs, until an adult is in their 30s [17]. At that point, white matter in that area begins to shrink. Craik and Bialystok explained the importance of this, saying, "Efficient cognitive functioning depends on the degree of myelination and integrity of white matter, on the density and richness of synaptic connections, and on the specificity of synaptic pruning caused by fruitful interactions with the external environment" (p. 132). These structural changes may lead to the declines in cognitive mechanics seen throughout the lifespan. In addition to structural changes in the brain, lifespan changes can also be seen in the neurotransmitters that facilitate brain functioning. For example, dopamine, which is necessary for executive functions, has been shown to decline with age [27]. A variety of changes in the neurophysiology of the brain throughout the lifespan, which are influenced by life events, the environment, and normal aging, contribute to changes that may affect adult learning.

Lifespan development also includes a gradual decline in episodic memory (memory of our experiences) in the third decade of life, increasing more rapidly after age 60 [26].

Fandakova et al. [28] suggested that this is due in part to a diminishing ability to bind specific knowledge with experiences, and Craik and Bialystok [17] noted the challenges associated with age in accessing stored memories. As we gain knowledge and experiences throughout our lives, we tend to forget the source of the knowledge or exact details. If adult learners are assessed on identifying the source of their knowledge when it is unimportant to the learning objective, this may put them at a disadvantage, educationally.

Fuzzy-trace theory posits that we simultaneously encode verbatim (exact details) and gist (essential meaning) memories from the same stimulus and that children are more likely to use verbatim memory in decision making while adults show a preference for gist memory [29]. The shift to gist-based memory also assists adults in seeing the "big picture" and realizing implications when presented with new information [26]. Coupled with a bias toward pattern completion, adults have a strength in integrating across experiences and knowledge [26]. Instructional strategies that emphasize gist memory, like summarizing, integrating multiple sources of knowledge, or identifying principles and guidelines, may be beneficial to adult learners. However, assessments that require adults to recall arbitrary details may be unnecessary. While some cognitive changes put adults at a disadvantage in higher education and e-learning, others could be utilized to assist with learning if they are considered in instructional design.

3 Marginalization of adult learners in higher education

Many initiatives, policies, and reports in higher education focus primarily or solely on traditional aged students, such as a recent report sponsored by the Pell Institute for the Study of Opportunity in Higher Education, *Indicators of Higher Education Equity in the United States: 2020 Historical Trend Report* [1]. This report only looks at students who complete their degree by age 24, completely omitting adult learners.

> When those who have the power to name and to socially construct reality choose not to see you or hear you … when someone with the authority of a teacher, say, describes the world and you are not in it, there is a moment of psychic disequilibrium, as if you looked in a mirror and saw nothing. It takes some strength of soul—and not just individual strength, but collective understanding—to resist this void, this non-being, into which you are thrust, and to stand up, demanding to be seen and heard [30, p. 2].

Some scholars have labeled adult learners in higher education a marginalized population, often noting their absence from the discourse. Tinto [31] noted, "In some respects, the experience of adult students is not unlike that of minority students. They too can feel marginal to the mainstream of institutional life" (p. 76). Pascarella and Terenzini [32] observed the absence of adult learners in the literature, calling this a "substantial" bias in the research (p. 152), noting this gap again in their 2005 research on the impact of college on undergraduates [33].

In a systematic review of the literature, Donaldson and Townsend [34] categorized the discourse on adult undergraduates with four labels: (1) invisible (the traditional student experience is presented as universal), (2) acknowledged but devalued (portrayed as "deficient, problematic, different, or other" (p. 37)), (3) accepted (treated as a separate homogenous population), and (4) embraced (intragroup differences are acknowledged and their value in higher education is described). The authors looked at all articles in seven leading journals in higher education from 1990 to 2003 and found that only 1% of them were about adult undergraduates, as indicated by their titles. Similarly, in their content analysis of the literature on diversity, Sims and Barnett [30] found "a gross omission in the literature concerning adult students" (p. 9). Their searches identified only two journal articles that addressed adult learners in terms of diversity, and five books that provided recommendations for working with adults; however, none of these works addressed the intersectionality of adult identities.

> Minority, female, gay, military, and disabled college student experiences are widely discussed in diversity sources, yet those same students are disregarded in the literature based on their age, educational background, family status, or life experiences. All of these dimensions of diversity are not all mutually exclusive and should be discussed together (p. 9).

Moreover, adult students of color are more likely to have negative past experiences with school and complete degrees at a much lower rate than White adults [35]. Students of color in online learning face multiple risk factors at a much higher rate than their White peers, such as living in crowded conditions, lacking access to computers or adequate broadband connectivity, having disabilities, or living in poverty [36]. Understanding the beliefs faculty have about adult learners will be important as this will affect how they teach and whether they value the assets their adult learners bring to the classroom [37]. Faculty pedagogical preparation can have an especially significant impact on Black students and Pell-eligible students, closing the achievement gap in some cases [38].

4 Conceptual model for meeting the needs of adult learners in distance education

There is a range of cognitive, social, emotional, and contextual constructs that are likely to impact adult learners in distance education (see Figure 2). Several of these overlap multiple domains, but they all interact with the adult learner context which shapes their impact [26, 39, 40]. In this section, I will describe how prior knowledge, cognitive load, working memory/cognitive processing, attention, executive function, self-regulated learning, motivation and self-efficacy, social identity, teacher presence, and life roles are important considerations for the design of instruction for adult learners in distance education.

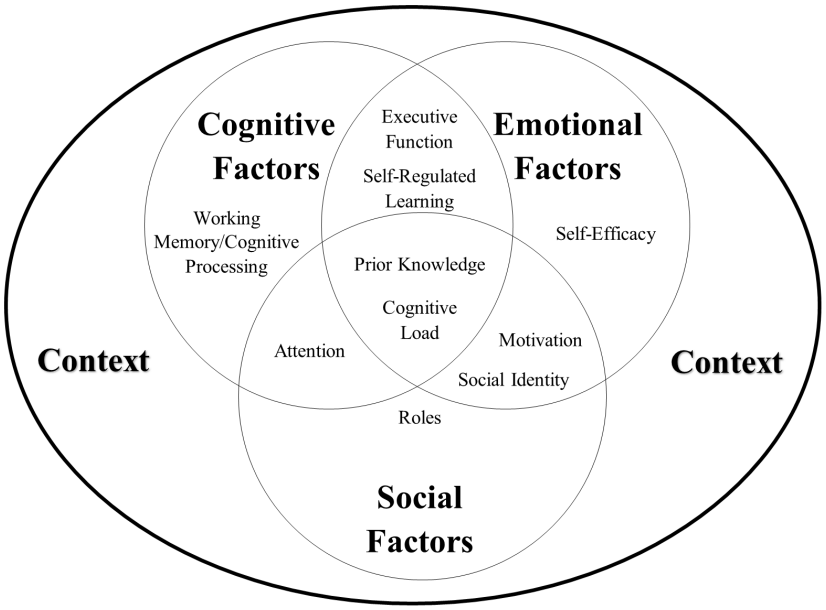

Fig. 2. Essential factors from the science of learning for meeting the needs of adult learners in distance education and e-learning

4.1 Cognitive factors

Prior knowledge. Overlapping all domains in this model are prior knowledge and cognitive load. Ambrose and Lovett [41] defined prior knowledge to include "content, skills, and beliefs, because all are 'knowledge' in that they result from past experiences and impact subsequent learning and performance" [41, p. 7]. Knowledge is a function of information and experiences stored in long-term memory which can be later retrieved and used [42]. It includes memories of our experiences (episodic memory), the knowledge we have distilled from these experiences (semantic knowledge), and our skills (procedural knowledge) [26, 43]. As learning is a matter of integrating new content and experiences into existing mental schema, distance education and e-learning can be improved when it activates and makes use of the prior knowledge and experiences of adult learners.

We form memories through a process of (1) encoding (the creation of memory traces through connecting new information, experiences, and meaning making with mental schema), (2) storage (consolidation and maintenance of memory), and (3) retrieval (using cues to recall and use the knowledge, reconstructing and strengthening the memory trace) [26, 42]. These knowledge stores are maintained and can be increased throughout adulthood [44, 45], although there is some evidence that identifying the source of the information becomes more difficult with age [19]. Effective instruction facilitates encoding, storage, and retrieval by providing authentic learning experiences

that integrate course content into prior knowledge, making connections to meaningful real-world challenges, providing adequate examples and practice, and encouraging students to explain their understandings.

As adults learn and grow through their formal education and life experiences, they accumulate a network of mental schema that can be an asset to them as students if tapped during learning activities [26]. This can be as simple as asking students to tell you what they already know about the topic, using a pre-test of the important content, or encouraging students to pause and reflect on what they have already learned in other areas of their life that might be useful in the lesson. However, it can also be a deficit as incorrect knowledge is harder to unlearn and biases us away from new information, and we often rely on these misconceptions to solve new problems [26, 46, 47]. Adults who have misconceptions may be resistant to unlearning and have a more difficult time replacing this knowledge in their minds. Even when they do replace these ideas, there is evidence that the original concepts still persist, creating a cognitive conflict and requiring inhibitory control, adding to the mental burden [48]. In fact, even scientists with PhDs in physics have been found to process information slower when the information conflicts with naïve understandings of physical phenomena [48]. Providing low-stakes multiple-choice questions with common misconceptions can be a simple way to identify these misunderstandings.

The prior knowledge and life experiences of adults effect not just their content and abilities but is also a component of their social and emotional interactions in learning and a product of their background and social context [26].This means that because they have a diversity of life experiences, adults are more variable as learners as they age. Universal Design for Learning (UDL) can be an effective pedagogical approach for addressing this learner variability in both higher education and workplace training [49, 50]. Providing multiple means of representing course content, multiple options and opportunities for engaging in learning, and multiple ways to act on and express their learning are the fundamental principles of UDL. For those new to UDL, the Center for Applied Special Technology (CAST) maintains a wealth of resources on their website at http://udlguidelines.cast.org.

Cognitive load. Cognitive load is the other central factor in this model to be considered in meeting the needs of adult learners in distance education. Cognitive load theory posits that working memory and mental processes have a limited capacity but are a combination of somewhat independent subprocesses interacting with mental schema from long-term memory [43]. These processes include intrinsic load (due to the complexity of the information), extraneous load (distractors or the processing required to access the information), and germane load (the remaining load available to devote to the intrinsic load) (see Figure 3). Intrinsic load can be reduced by breaking complex concepts into simpler chunks, using retrieval practice to automate prerequisite skills and knowledge, using metaphors or other cognitive scaffolds to structure new information, and connecting new information to prior knowledge [43, 51]. Efforts should be made to minimize extraneous load that detracts from the learning process. This might be overly complex explanations, disorganized content, the splitting of attention to focus on information in multiple places, or the load maintained by thinking about other life responsibilities and negative self-perceptions. The goal is to devote as much of a

learner's available mental capacity to the germane load required to process and learn the content. The more mental capacity available for germane cognitive load, the better the learning outcomes.

Cognitive load is variable for each learner because of their background knowledge [43], level of social and emotional skill and involvement [52, 53], and their background and situational context [54, 55], but there are instructional strategies that can be developed to mitigate extraneous cognitive load. Mayer [51, 56] suggested several strategies for reducing extraneous cognitive load. These include eliminating unnecessary words and images, highlighting essential words and pictures, integrating labels within diagrams rather than placing them side-by-side, narrating visual elements, avoiding narration that competes with written text on the screen, and presenting a preview of content before beginning the lesson. Cognitive load is an especially important consideration in distance education because of its interactions with cognitive and social presence [57]—and for adults in particular, as their working memory capacity and speed declines with age [19, 45].

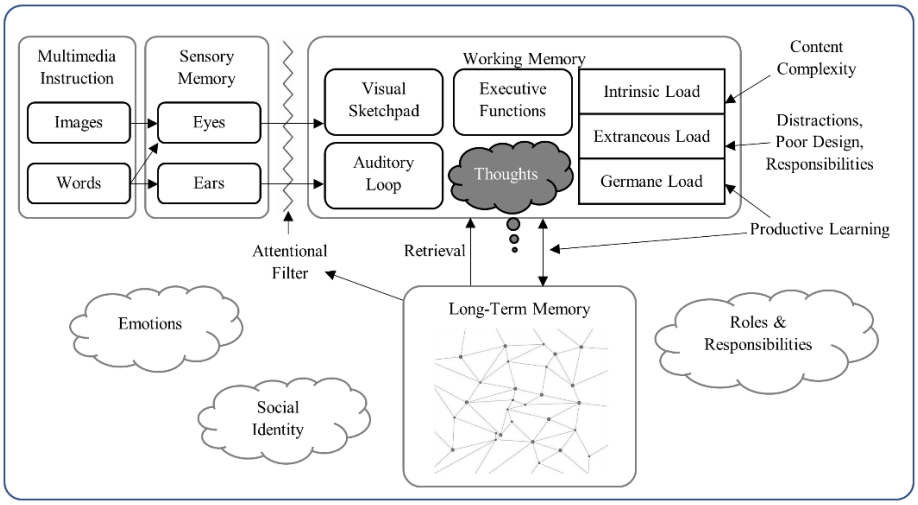

Fig. 3. A model of adult working memory based on Mayer's cognitive theory of multimedia learning with the addition of cognitive load and other related factors affecting memory [42, 43, 51, 58, 59]

There are several models of working memory, but the one most appropriate to distance education and e-learning is the cognitive theory of multimedia learning (see Figure 3) [51]. Mayer explained that words and images are presented in multimedia instruction which we perceive using our sensory memory. Our working memory helps us to (1) select the appropriate words and images to focus on, (2) organize the verbal and pictorial models, and (3) integrate these with prior knowledge from our long-term memory. Beginning in early adulthood, working memory and processing speed begins a gradual decline throughout adulthood, indicating that these three tasks are less efficient in adult learners [19, 45]. There is evidence associating this decline with a loss of volume in the prefrontal cortex [60, 61]. Mayer's theory of multimedia instruction,

described above, can be used to mitigate the demands of mental processing, while other research suggests that the ability to pace their own learning has positive benefits for adult learners [44, 62]. There are several other learning strategies that are particularly useful for limited working memory capacity, such as retrieval practice [63] or making non-threatened identities more salient for those that experience stereotype threat, as discussed below [64].

Retrieval practice is especially beneficial as it can automate necessary information and skills to free working memory to focus on more complex tasks. This can be accomplished through frequent low-stakes quizzes or knowledge checks, reviewing information with flashcards and games, and asking students to write about or verbally explain what they are learning, to the instructor or to each other. Recognition is a weak memory trace as it only requires a learner to identify something as familiar when they are presented with it again. However, free recall requires the learner to generate the information without cues, leading to stronger encoding, processing, and deeper memory traces. Faculty and e-learning designers should provide opportunities for information recall to assist with learning, rather than tasks that only require recognition.

Attention. Selecting which information makes its way into working memory is the role of attention (see Figure 3) [65]. Attention is a finite resource susceptible to depletion with high demands [66]. Because adult learners in higher education often have multiple roles [13, 67], their attention is more likely to be divided or used to maintain these other roles. Switching between tasks has a high cost in time and memory which negatively impact learning, putting learners at a disadvantage in distance education and e-learning where learners are often multi-tasking or working in distracting environments [59, 68]. Knowing in advance that there will be an interruption or switch allows the learner to clear their working memory and prepare to focus on something new. If the task is switched without preparation, like with an interruption, the impact on attention will be more negative in terms of cost. This supports other research that demonstrates the benefits of self-paced learning for adults as well as the benefits of chunking course content and learning activities into smaller segments [51, 62].

Executive function. The control processes responsible for "planning, assembling, coordinating, sequencing, and monitoring other cognitive operations" are referred to as executive functioning, a metaphor of a business executive who does not specialize in a particular task but manages all tasks [69, p. 566]. Craik and Bialystok [17] explained that executive functions "overcome the prepotent 'default mode' of automatic behavior and allow the person to attend selectively, to concentrate on a particular task, to make choices in line with current goals, and to facilitate new learning and adaptive responding" (p. 134). Executive functions are particularly important in distance education and e-learning which are often self-directed learning modalities, requiring the learner to plan, sequence, monitor, and control their learning activities, while inhibiting distractors, directing their attention, and adapting to change [68]. Executive functions are potential mediators of age-related cognitive declines, yet there is evidence that these skills can be improved with practice [70]. For example, there is some evidence that strategy training and core working memory training can have far reaching benefits for adults [71, 72]. While many of these executive functions are naturally supported in the traditional face-to-face classroom, they are often less present in the design of asynchronous online learning.

Self-regulated learning. Addressing executive functions in distance learning is important as these skills underlie effective self-regulated learning [73], which are significant predictors of academic achievement [74]. Adult learners are often lacking the strong self-regulation skills necessary for success [75–77]. Pintrich [78] defines self-regulated learning as "that which involves the active, goal-directed, self-control of behavior, motivation, and cognition for academic tasks by an individual student" (p. 5). This includes planning, monitoring, controlling, and reflecting on learning. Social-emotional aspects of self-regulated learning, such as self-efficacy, may be particularly relevant for adults in distance education [79]. Self-regulated learning is not improved simply by participation in online learning [75], but these skills can be taught and improve outcomes for adults in distance education [80]. Faculty and e-learning designers can help support self-regulated learning by modeling task analysis, breaking larger learning assignments into smaller parts, estimating the time it will take to complete each activity, planning when to complete the tasks, and using a checklist to keep track of progress. Another important component of self-regulated learning is reaction and reflection. Asking adult learners to reflect on their learning processes, feelings, motivation, behaviors, interactions, and environment can help them to accurately attribute successes and failures and identify strategies for improving their learning.

4.2 Social factors

Roles. Working adults in higher education are twice as likely to consider themselves "employees who study" than "students who work," identifying first as an employee [13]. Employees who study are older, more likely to be married and have children, attend school part-time, and work full time. Their goals for participation in higher education are to improve their career prospects, but also for personal enrichment [23]. Adults in higher education balance multiple roles, such as work, caregiving for children and older relatives, community engagement, and volunteer work [67]. Role strain can be particularly challenging for working mothers in higher education who can experience conflicting demands, overload, and guilt [68, 81]. It is important to consider the multiple roles of adult learners as these carry a time and attention burden that is not present for most traditional-aged college students [82]. These roles contribute to the amount of attention that can be devoted to learning activities as well as extraneous cognitive load. Instructors and e-learning designers can consider streamlining course content to minimize the time and attention required of the adult learner as well as using authentic contexts for course content that are personally relevant to the learner and align with their life roles.

Social identity. Marginalized identities place additional burdens on adult learners. General social identity threats come from perceived situational cues that imply the devaluing of one's identity [83]. When a learner experiences stereotype threat, or the fear that they will meet negative expectations set by society based on their identity [84], this taxes executive functions, increases worry and anxiety about failure, and places limits on working memory [26]. The effect is even greater in situations where the learner is especially motivated [85]. Adults with marginalized identities may attribute challenges or failures in higher education or e-learning to a belief that they don't belong there, not thinking that challenges are common to most learners [26, 86].

Stereotype threats arise from four conditions: (1) the individual is aware of a stereotype of their social group (e.g., suggesting that women are bad at math or older people cannot learn technology skills); (2) the individual is confronted with an evaluative task that will demonstrate their ability, like e-learning or assessment; (3) the task is challenging; and (4) the individual is motivated to perform well and identifies with the stereotyped group [83, 86]. The negative effects of stereotype threat can equate to performing one half of a standard deviation below one's actual performance [83]. Identity contingency cues that may promote stereotype threat include underrepresentation, interpersonal cues of incivility and negative behavior, critical feedback, color-blind statements and policies, and fixed-ability beliefs and messages [83]. Creating a warm and welcoming virtual classroom environment or workplace can lesson stereotype threat. Threats to social identity can produce a cognitive load [64, 87], but efforts to remind students of their other life roles and de-emphasize the salience of the threatened identity can mitigate this threat [88, 89].

Social identity is an important factor in the success of any learner, but there are particular components of identity and self-concept that are relevant for adults in distance education and e-learning. Higher education poses challenges for learning, and adults who have a more fully developed self-concept may be sensitive to their changing abilities and are likely to protect this self-concept through avoidance and compensation [23]. Adult learners may avoid learning activities that rely heavily on their declining cognitive mechanics, while also seeking to demonstrate their breadth of knowledge in areas of perceived competence. Protecting self-concept can lead middle-aged and older adults to choose certain types of career development activities and avoid others [90].

There is evidence that instructing adults on the benefits of committing errors during learning and giving them the freedom to make these errors has positive effects on their learning [91, 92]. For example, because older learners have more negative reactions to making mistakes in computer training, Carter and Beier [91] developed an error management training as an intervention. They found that this training was beneficial for adults, even in highly structured activities where there was less room for error, and especially so for adults with higher cognitive ability who might have been more likely to protect their self-concept by avoiding opportunities for mistakes. Carter and Beier argued that, while self-paced learning is beneficial for adults, it may take too long. They suggest that combining high structure and error management training can reduce the time for self-paced learning.

Social presence. Social presence of any kind online can be defined as "the degree of feeling emotionally connected to another intellectual entity through computer mediated communication" [93, pp. 1738–1739]. Learning is socially contextualized because it involves "the experiences, social relationships, and cognitive opportunities as subjectively perceived and emotionally experienced by the learner" [26], whether the learner is working alone or with others. Even in self-paced individualized online learning, students are still socially connected to a real or imagined instructor who is providing the instruction.

Social presence online has been studied in terms of cognitive presence (intellectual connection to course content), social presence (connections to other students), teaching presence (sense of connection to the instructor), and other forms of presence [94]. Indicators of social presence can be affective (expressions of emotions or mood),

interactive (acknowledgement of another), and cohesive (things that build or sustain group cohesion) [95]. Adult learners find teaching presence to be essential for their learning and seek deep interactions with content rather than surface learning, with peer interactions a bonus [96, 97]. Mayer [51] suggested that this connection helps to foster deeper processing during learning. The Community of Inquiry (CoI) model can be helpful in designing for cognitive, social, and teaching presence and addressing the emotional needs of adult learners [98, 99]. Embedding course content into social contexts, such as through stories, scenarios, or case studies, can help the learner connect to the content. Mayer [51] explained that using real human voices with conversational language in e-learning can increase a sense of social partnership with the instructor, leading to increased effort and attention on the part of the learner.

4.3 Emotional factors

Motivation. Adults are increasingly motivated to obtain emotional meaning from life [23, 98, 100], and their brains are too efficient and overloaded to learn something that is not meaningful—if there is no emotional connection to the content, such as curiosity or motivation to learn, the information will not be remembered [58]. Motivation is an important consideration for distance learning as some research has found lower levels of motivation in online learners with high correlations to course performance [101]. A meta-analysis of the research on motivation in adult learners found that adults who chose online courses were intrinsically motivated and had high self-efficacy, while instructional design strategies that were associated with high motivation included building on learners' life experiences and allowing for personal control in when, where, and with whom to learn [102].

Self-efficacy. One particularly relevant component of motivational theories for adult learners is self-efficacy [23] and its role in situated expectancy-value [40] as growth and accomplishment are important factors in motivation for adults [26]. Self-efficacy has been defined as "the belief one has in their own capabilities to perform certain tasks" and has a significant impact on the academic and training performance of adult learners [103, pp. 113–114; 104]. To be an adult means to be competent, although when adult learners enter higher education, "they compartmentalize their prior understandings of self-efficacy and competence in their adult life worlds, believing that their backgrounds have limited or no value in the academic world" [15, p. 31]. Many adults will try to protect their self-image by taking steps to avoid failure, rather than take risks to improve learning [91]. Educational environments that encourage risk-taking and provide psychological safety can allow for adults to engage more deeply in learning. Strategies for improving self-efficacy in learners include helping students to set appropriate goals, helping them to break them down into subgoals, and providing feedback on progress so students can attribute their success to their own efforts [26].

Eccles and Wigfield [40] contended that significant impacts on performance come from the individual's expectancies for success and subjective task values. Expectancies of success, or the learner's belief about how well they will do on a task, are influenced by their beliefs of personal efficacy, academic self-concept, and perceptions of task difficulty. Subjective task values are determined by intrinsic value (anticipated

enjoyment or interest), attainment value (identity-based importance), utility value (means to an end), and cost (including the amount of effort needed, time away from other valued tasks, and emotional costs related to anxiety and failure) [40]. Helping learners to reflect on these components and making them explicit can help them to increase their value, self-efficacy, and motivation. Faculty and e-learning designers can use this framework to design learning tasks that their adult learners will value and complete competently.

5 Conclusion

Understanding the needs of the adult learner in distance education and e-learning is important for improving their experience and outcomes. By combining cognitive, social, and emotional factors, accounting for unique contexts, we can develop programming that meets the needs of the whole learner. While the extant literature shows support for the individual factors in this model, further research should be conducted to test the significance of this model as a whole. Research in these areas has primarily been conducted on school-aged children or traditional college-aged students in classroom or lab environments, so ecological validity and focus on adult learners will be necessary. There is a diverse body of evidence-based instructional practices to support each of the factors in this model, but additional research may show significant interaction effects that may be especially beneficial for adult learners in distance education and e-learning.

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Nudging Lifelong Learning and Reflective Thinking in Engineering Students Utilizing LinkedIn Learning

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Abstract—Most engineering and technology-focused program curricula are firmly fixated on the required technical skills to meet the profession's needs. However, in today's rapidly changing, globalized world, engineers and technologists need more than technical competencies to meet the requirements of their professional work. This work illustrates how the LinkedIn Learning (LiL) platform was used as a "learning partner" to complement undergraduate engineering technology management courses to enrich reflective thinking and nudge lifelong learning tendencies. The rationale for integrating LiL into the course framework is examined, including study design and survey results. Summary research indicates that students appreciated the LiL coursework assignments. Most respondents perceived the LiL courses increased their knowledge and skills in the subject matter. The study illustrated a movement towards self-determined learning behaviour and improved reflective capabilities.

Keywords—engineering education, reflective thinking, digital learning tools, summarization, asynchronous learning, engineering management

1 Introduction

This paper illustrates how the LinkedIn Learning (LiL) platform was used as a "learning partner" to complement two engineering management courses' content to enrich metacognition reflection outcomes and nudge students toward lifelong learning tendencies. Research on the contemplative dimension of learning and the importance of lifelong learning for engineering students is surveyed. The rationale behind integrating LiL as a learning partner and how the curated third-party learning content was interwoven asynchronously into the course framework are discussed. The study also provides research on the student's perspective on using LiL as a complementary learning asset, including limitations.

Let's begin by explaining the LiL platform and its use in higher education. LiL is a self-service curated digital learning platform owned and operated by Microsoft Corp. with over 16,000 + video tutorials (VTs) in multiple languages within the topic categories of business, creativity, and technology [1]. Microsoft promotes LiL enterprise licenses

to teams, companies, and organizations who wish to access the learning platform. As part of its Career KickStart strategy, the Ontario government funded access to the LiL platform on behalf of all higher education institutions in the province from 2017 to 2020 [2]. Building on this opportunity, McMaster University recently negotiated and secured a multi-year institutional enterprise license, allowing free access to LiL for all active students, faculty, and staff. This institutional access enabled the author to integrate LiL VT assets into two engineering management courses.

2 Learning perspectives

2.1 Metacognitive learning

Metacognition is thinking about one's thinking. More precisely, it refers to the processes used to plan, monitor, and assess one's understanding and performance. Metacognition includes a critical awareness of a) one's thinking and learning and b) oneself as a thinker and learner [3]. When learners engage in metacognitive reflection, it contributes to helping them understand what they have learned and transferring new knowledge into other contextual situations.

Most engineering and technology-focused program curricula are firmly fixated on the required technical skills to meet the profession's needs. However, in today's rapidly changing, globalized world, engineers and technologists need more than technical competencies to meet the requirements of their professional work. Reflection, or the contemplative dimension of personal learning, has not historically received much attention in engineering education, despite calls for more significant consideration of using reflection. For example, in a National Academies piece calling for curricular change in undergraduate engineering, Ambrose [4] suggests that learning happens with reflection, and instructors should "provide structured opportunities to ensure that reflection occurs." Indeed, published evidence indicates that students reflecting on their learning enhance metacognition and learner agency [5, 6, 7].

Although it is not mainstream, reflective practice is not new in engineering education. Many have drawn on Schon's [8] work on the "reflective practitioner" and how "reflection-in-action" and "reflection-on-action" can influence professional education [9, 10, 11, 12, 13]. Other researchers have emphasized the value of reflective thinking and underlined that students do not automatically learn from experience [14]. Instead, reflection as an intentional and dialectical way of thinking about an experience to inform future actions should be encouraged in engineering education [15].

Both technical skills and metacognitive development are essential for achieving the goals of a "whole" engineer education, but the latter is often shortchanged or not deliberately explored. It's usually only implicitly hinted at in teaching, if mentioned at all. One reason is that facts, technical knowledge, and skills are easier to measure, but reflecting on learning is much harder to assess. However, if you ask employers what they seek in an engineering graduate, they often state elements related to the candidate's learning character. They are not looking for applicants solely focused on technical abilities but individuals who are more metacognitively aware and reflect on their process for achieving specific results within organizational parameters.

2.2 Lifelong learning

The research literature on lifelong learning has grown exponentially in the past few decades [16]. The emergence of governmental and economic policies promoting lifelong learning, and the proliferation of curated digital learning platforms has ushered in a new era in which education is ongoing. Changes in technologies, increasing demands of the new economy, fierce global competition, and the growth of increasingly well-informed and well-educated consumers create new markets for the education sector [17]. Lifelong learning is, thus, becoming a sector of mass participation, particularly as people in developing countries realize that their financial survival depends on it.

For this reason, the Government of Ontario's Career KickStart strategy has emphasized the issue of lifelong learning [2]. According to Knapper and Cropley [18], lifelong learners are active learners who plan and assess knowledge rather than wait for others to prepare for them. They can learn from their peers, teachers, and mentors in formal and informal settings. They can apply their knowledge to different contexts and are astute users of different learning strategies for unique situations. This self-directed learning mindset is imperative in this era of unprecedented rapid and fundamental change, in which some graduates will never directly use the disciplinary knowledge they acquired in university [19].

Today's engineering technology professionals work in a continual change and innovation ecosystem. To meet this challenge head-on and remain competitive, technical professionals must be content experts, highly skilled problem solvers, team players, and lifelong learners [20]. Therefore, one of the critical issues for higher education should be whether students are developing a belief and commitment to lifelong learning. Nudging students to adopt early habits and tools for lifelong learning is something we need to help learners embrace before they leave our institutions. One way to enhance this awareness is to interact with curated learning platforms, such as LiL, typically outside university parameters. Indeed, as educators, we should encourage metacognitive reflection and endeavour to nudge students towards lifelong learning tendencies to achieve the ambitions of "whole" engineering education.

3 The study and results

3.1 The coursework

The undergraduate engineering technology programs within McMaster University W Booth School of Engineering Practice and Technology integrate technical comprehension with cross-boundary skills in business and management. The author integrated LiL into two engineering management courses, a fourth-year Entrepreneurial Thinking and Innovation course and a second-year Management Principles course. Both courses had students enrolled across the program streams of Automotive and Vehicle Engineering Technology, Biotechnology, and Automation Engineering Technology.

The Entrepreneurial Thinking and Innovation course introduces students to the interrelationship of entrepreneurial thinking and innovation at industrial and individual levels. It is project-based learning (PBL) course focused on developing an enterprise-level

business case for a real organizational opportunity. The Management Principles course, on the other hand, is a fundamentals course examining the management principles of planning, organizing, leading, and controlling in technology organizations.

In both courses, students were assigned to watch three separate LiL video courses throughout the term and complete a written VT Report assignment for each. The report was limited to 1500 words (3 pages single-spaced) with two parts. In Part A, the students were required to summarize what they considered the most important ideas/concepts from the VT, written in a straightforward narrative that assumed the "reader" had not watched the LiL VT course material. The reflection component of the assignment was Part B. Learners were required to explain and articulate multiple connections between what they comprehended from watching the VT and connect it to prior learning in other courses or life/work experiences and future goals. Students were provided but were not limited to the following questions to help guide and facilitate their reflection process:

- What was the most important part of this video tutorial for me? Why?
- What new skill or "piece" of knowledge did I acquire after the video tutorial? Why?
- I could see myself using this knowledge in my course or a future (or previous) workplace role. Why?
- After the video tutorial, I will change_____. Why?
- Now I understand _____ after watching the video tutorial. How will this new understanding be helpful for you?

The VT reports were worth 15% of the final course grade. However, the worth of each assignment is scaffolded, starting at 3% for the first report, 5% for the second, and 7% for the third. A lower percentage assigned to initial reports enabled students to practice and learn from their shortcomings. Each student was provided extensive written feedback from the Teaching Assistants and allocated a standardized rubric score. Grading was completed promptly, so students could incorporate the feedback to enhance their performance before submitting the subsequent VT assignment.

3.2 The assignment rationale

The author found LiL an efficient way to reinforce industry-specific approaches and bring complementary skill attainment into the course learning environment. It also allowed students to experience other voices through the LiL course instructors. A clear pedagogical advantage exists when students can access experts through platforms that ensure a rigorous talent selection process, such as LiL, versus the sometimes-dubious origins of many open-source videos.

Being able to summarize has become a skill that is more important than ever in today's information overflow. Learning how to summarize helps learners understand the novel and challenging subject matter, which they can apply to solving problems or developing a project. According to Kintsch, Eileen et al. [21], summarization has several advantages: promoting deeper thinking and analysis to select the relevant information; teaching essential study skills, such as identifying important content and separating main ideas from details. Summarizing is a way to develop a solid understanding of complex material and articulate one's understanding to be shared

with others. Converting the most important information concisely and accurately without wasting time or causing misunderstandings is a skill many engineering managers prize in their employees, and engineers appreciate their supervisors [22].

However, the fundamental pedagogical rationale for incorporating coursework requiring students to interact with the LiL platform was to encourage the development of contemplative learning and nudge lifelong learning tendencies. The work presents an innovative undergraduate training experience using LiL as a "learning partner" in two undergraduate engineering technology management courses. Analyzing students' perceptions and the impact on knowledge and skills allows for an understanding of the effects of self-reflection and self-determined learning in the short-term. The work is positioned as a forerunner concerning improving the university engineering education models to prepare students for today's dynamic workplaces.

3.3 Student perceptions

At the end of the term, students were invited to complete a short online questionnaire to explore their perceptions about the VT Report assignments and their experience using the LiL platform. The survey was entirely anonymous, and participation was optional. The questionnaire consisted of eight closed-ended question items. The first two dichotomous questions explored their use of the LiL platform for academic credit and usability. The following four questions surveyed their perception of the knowledge and skills gained in the subject matter from each of the three LiL courses. These questions used a five-point Likert scale, ranging from (1) strongly agree, (2) agree, (3) neutral, (4) disagree, and (5) strongly disagree, along with not applicable option. The final two questions probed the likelihood of the students using the LiL platform in the future and sharing their digital certificates of achievement on their social media platforms. These final two questions used a five-point Likert scale for likelihood, ranging from (1) extremely likely, (2) very likely, (3) moderately likely, (4) slightly likely, and (5) not at all likely.

Surveys were conducted across three different years in two separate courses — the first measured students in a fourth-year Entrepreneurial Thinking & Innovation course in the fall 2019 semester. There were 85 students enrolled across two sections that the author taught. The overall participation rate was 44.7%, with 38(n) students completing the survey. The other course was a second-year Management Principles course delivered in the winter semester of 2021. There were 250 students enrolled across four sections that the author taught. The overall participation rate was 34.4%, with 86(n) students completing the survey. Lastly, the Entrepreneurial Thinking & Innovation course was surveyed again in the winter 2022 semester. There were 118 students enrolled across two sections that the author taught. The overall participation rate for this cohort was 23.7%, with 28(n) students completing the survey. The questionnaire results indicated that students overwhelmingly felt the LiL platform was easy to use. The assigned LiL VTs were well received, and between the three surveys, there was an increased interest in using LiL for self-directed learning in the future.

Table 1 is the results from the first survey question, "Was this the first time you have used the LiL platform as part of a graded assignment in a university course?" For the most part, this was the first time students had used LiL for a graded assignment

in their courses. In 2019, a small cohort of students used LiL in another technical class, which would account for the 3% answering no to the question. The no response increased slightly in 2021, as more instructors within the school incorporated LiL into their courses during the switch to online instruction during the COVID-19 pandemic. The adoption of the LiL increased by 2022, with 29% of students indicating they had used it as part of their university education. This suggests that faculty members increased their use of LiL to complement their virtual course instruction during the pandemic.

Table 1. LinkedIn learning usage within academic courses

	Entrepreneurial Thinking (F2019)	**Management Principles (W2021)**	**Entrepreneurial Thinking (W2022)**
Yes	97%	91%	71%
No	3%	9%	29%

Table 2 illustrates the results from the second question, "Was the LinkedIn Learning platform easy to use?" Again, most students indicated that the LiL was easy to navigate. One of the contributing factors to the higher percentage in the "somewhat" category in the 2019 survey was that some students had challenges with the export functionality of the notebook feature within LiL that allowed users to take notes within a course while watching. The problem was detected after the first VT report assignment. Subsequently, the instructor encouraged the students not to use the notebook feature within LiL and to create summary notes outside the platform to reduce difficulties. The most likely reason for fewer problems with the LiL platform from the 2021 and 2022 surveys was that students were exploring LiL for personal use and becoming more adept at navigating online technology platforms due to the mandatory virtual classes during the pandemic.

Table 2. Ease of use of the LinkedIn learning platform

	Entrepreneurial Thinking (F2019)	**Management Principles (W2021)**	**Entrepreneurial Thinking (W2022)**
Yes	87%	95%	93%
Somewhat	13%	5%	7%
No	0%	0%	0%

Figure 1 depicts the four items that dealt with the educational value of the LiL VTs in the F2019 Entrepreneurial Thinking & Innovation course. The students perceived the grading criteria positively for the VT Report assignments. Most students concurred that the first two LiL VTs offered educational value. For both these LiL courses, 79% agreed or strongly agreed that the LiL course increased their knowledge and skills in the subject matter presented. Sixty-eight percent perceived that the third LiL VT, "Presenting as a Team," was not as valuable in enhancing their knowledge and skills. Anecdotally, students believed they already had sufficient experience presenting, given they were seniors, so this LiL course content was allegedly less valuable from their perspective.

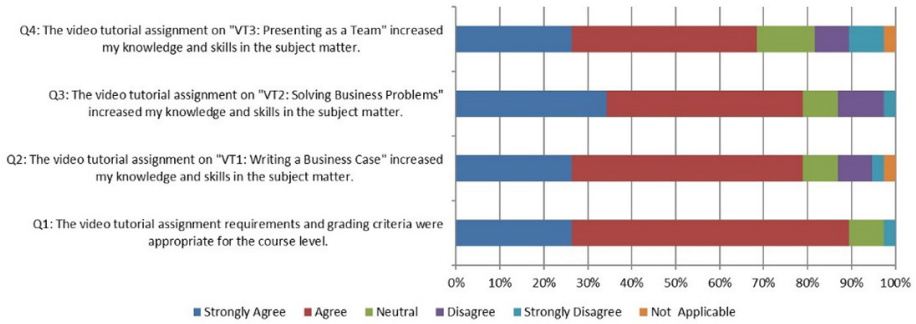

Fig. 1. Descriptive F2019 survey results for the LiL educational value in the entrepreneurial thinking & innovation course

Figure 2 depicts the four items that dealt with the educational value of the LiL VTs in the W2021 Management Principles course. Again, the students generally perceived the grading criteria positively for the VT Report assignments. Most students surveyed indicated that all three LiL VTs offered educational value. For the VT on "Being an Effective Team Member," 88% agreed or strongly agreed that the LiL course increased their knowledge and skills in the subject matter. Just over 89% perceived the "Giving and Receiving Feedback," as valuable, and the third LiL VT, "Management Foundations," just shy of 92% agreed or strongly agreed it enhanced their knowledge and skills in the subject matter.

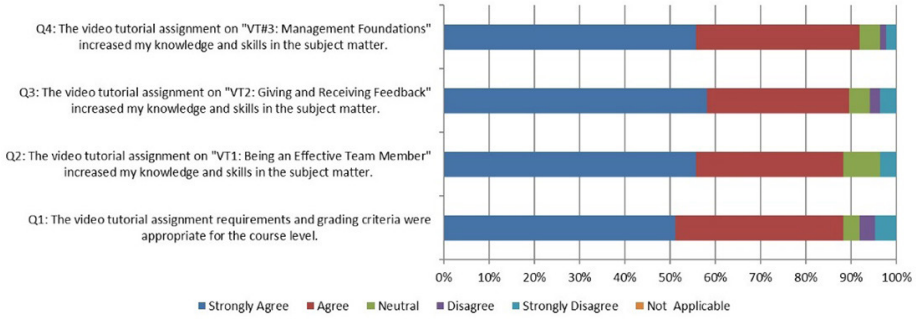

Fig. 2. Descriptive W2021 survey results for the LiL educational value in the management principles course

Figure 3 depicts the four items that dealt with the educational value of the LiL VTs in the W2022 Entrepreneurial Thinking & Innovation course. Again, students perceived the grading criteria positively, and all the VT Report assignments were useful in enhancing their learning. In the first two LiL courses, 93% and 89% agreed or strongly agreed that the courses increased their knowledge and skills in the subject matter. The third LiL VT, "Become an Entrepreneur Inside a Company," replaced "Presenting as a Team," leading to an increase of 82% agreeing or strongly agreeing of perceived educational value compared to the F2019 rate of 68%.

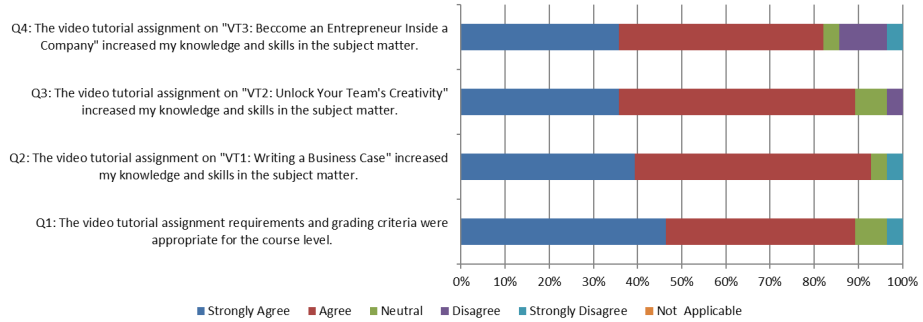

Fig. 3. Descriptive W2022 survey results for the LiL educational value in the entrepreneurial thinking & innovation course

Table 3 displays the results from the seventh survey item focused on the tendency to use the LiL platform in the future. This question aimed to validate whether the nudge toward lifelong learning predilection was beginning to take hold. In the 2019 survey, 31.6% indicated they were extremely likely or very likely to continue using LiL independently. Conversely, this measure rose to 47.7% in 2021 by survey respondents. The 2021 students exemplified a positive shift towards self-determined learning behaviour in the short term compared to the 2019 respondents. However, in the 2022 survey, there was a decline, with 39.3% indicating they were extremely likely or very likely to continue using LiL independently. It's still a positive indicator for learner agency; however, this decline compared to 2021 may imply online learner fatigue by the respondents because of the imposed virtual instruction during the pandemic.

Table 3. Future use of the LinkedIn learning platform

	Entrepreneurial Thinking (F2019)	**Management Principles (W2021)**	**Entrepreneurial Thinking (W2022)**
Extremely Likely	10.6%	18.6%	17.9%
Very Likely	21.1%	29.1%	21.4%
Moderately Likely	36.8%	34.9%	39.3%
Slightly Likely	18.4%	12.7%	21.4%
Not at all Likely	13.2%	4.7%	0%

The VT Report assignment deliverables clarified that a digital certificate of achievement would be awarded to students when they completed each LiL course. They could publish this digital certificate on their LinkedIn professional profile to display to potential employers and other career influencers. Table 4 indicates the respondent's likelihood of exhibiting their digital certificates. In the 2019 survey, 32% indicated they were extremely or very likely to display their earned LiL course digital certificate. The 2021 survey revealed that 55% of respondents were extremely or very likely to exhibit their digital certificates. Given that the 2021 students were sophomores, this positive difference could be rationalized because they wanted to enhance their professional profile to help secure a future paid workplace internship, a requirement for all students in the W Booth School. Forty percent of the respondents in the senior course in 2022

indicated they would exhibit their digital certifications, which was an upward trend compared to the 2019 cohort in the identical course.

Table 4. Likelihood of displaying LinkedIn learning digital certificate of achievement

	Entrepreneurial Thinking (F2019)	**Management Principles (W2021)**	**Entrepreneurial Thinking (W2022)**
Extremely Likely	13%	25%	11%
Very Likely	19%	30%	29%
Moderately Likely	24%	29%	21%
Slightly Likely	21%	7%	18%
Not at all Likely	18%	7%	18%
Unaware of Certificate	5%	2%	3%

3.4 Student reflection performance

As stated in section 3.1, students were required to explain and articulate multiple connections between what they comprehended from watching the LiL VT course and connect it to prior learning in other courses or life/work experiences and future goals. This reflective exercise aimed to help students enhance metacognition and learner agency.

The VT Report assignment reflective component was weighted at 35% of the overall assignment worth. It was assessed using a rubric that assigned points ranging from 17.5 to 0 based on performance identified as (1) target, (2) acceptable, (3) developing, (4) unacceptable, and (5) incomplete. A student achieving target performance exhibited an in-depth analysis demonstrating the value of the derived learning to self and enhancing the learner's appreciation of the concepts. This involved articulating multiple connections between prior learning in other courses or life/work experiences and future goals. On the other hand, if a learner's reflection only described the VT learning experience and did not articulate any connection to prior learning or life/work experience, they would earn an unacceptable performance score. Scores landing between the target and unacceptable performance levels were more descriptive than reflective. Generally, they lacked a personal connection to the learning, or the linkages were vague or unclear.

Table 5 displays the change in the overall average student scores for the reflective component from each VT Report assignment to measure the difference in reflective performance. The 2019 cohort of students enrolled in the Entrepreneurial Thinking and Innovation course exhibited positive change, just over 5% in their reflective performance from the first to second VT Report. However, there was a slight decline in performance from the second to third VT Report. However, the reflective performance improved slightly from the first to the final (third) VT Report.

In comparison, the student cohort enrolled in the 2021 Management Principles course exhibited a positive change in reflective performance across all the VT Reports. From the first to the second, just over 7% improvement and from the second to third, VT Reports indicated a 6.5% positive difference. The performance change from the first to the third VT Report exhibited slightly over a 14% improvement.

The 2022 students enrolled in the Entrepreneurial Thinking and Innovation course indicated less of a positive change in their reflective performance than the 2019 student

cohort and certainly compared to the 2021 Management Principles students. However, the reflective performance improved from the first to the third VT Report.

Overall, the students enhanced their reflective capabilities as they completed the VT Reports. This would suggest they benefited from the repetition of reflective thinking and receiving guided feedback to improve their learner agency.

Table 5. Changes reflective performance across VT assignments

	Entrepreneurial Thinking (F2019)	**Management Principles (W2021)**	**Entrepreneurial Thinking (W2022)**
VT1 to VT2	+5.41%	+7.11%	+2.50%
VT2 to VT3	–0.64%	+6.52%	+1.60%
VT1 to VT3	+4.73%	+14.10%	+4.10%

3.5 Study limitations

The study, as described, had several limitations. First is its small scope, with only 123 students surveyed across two courses with the same instructor. The small sample limits the study's transferability, and the positive impact could be linked to the instructor's familiarity with the students and unconsciously advocating for the LiL platform. Another limitation of the research was reliance on only eight closed-ended participant-reported questionnaire statements that primarily focused on students' perception of the VTs and the LiL platform. Finally, students lacking English proficiency could have difficulty understanding and summarizing the LiL video courses. This notable lack of mastery and confidence in language skills has been identified by other researchers regarding writing tasks, like summarizing, which require articulating ideas, not their own [23].

Educational institutions' changes may have influenced the shift between the 2019 and 2021 student cohorts through the 2020 pandemic, which involved much more intensive use of technology and remote learning platforms, such as LiL. The 2021 cohort's positive shift towards self-determined learning could be a collateral outcome of comfort and familiarity with online asynchronous digital learning platforms. This cohort may also have a different predisposition toward diverse ways of learning or a more active interest in honing other skills, given that they were sophomores.

Future studies would benefit from a more deliberate research design incorporating longitudinal pre-and-post surveys from two different survey instruments: one, instrument measuring self-efficacy, and the other, lifelong learning tendencies. Self-efficacy is a construct studied in many contexts, including learning, individual entrepreneurship, technology solutions, innovativeness, change, and task completion. Studies have found that self-efficacy significantly relates to people's engagement in change and personal development [24].

The challenge is to provide students with educational experiences that enhance their aptitude for continued self-directed learning and help them gain enough confidence to initiate, maintain, and finish any endeavour they like. So one of the most critical issues for engineering education should be whether students are developing a belief in and commitment to lifelong learning [25]. Investigating the factors contributing to reflection and lifelong learning is critical to encouraging dynamic engineering professionals.

4 Conclusion

Specifics were shared about the experience of using LiL as a "learning partner" in two undergraduate engineering technology management courses. The study revealed that students valued integrating the LiL assignments into the coursework. The work also demonstrated that most respondents strengthened their skills in summarizing industry-related best practices and self-reflection capabilities. Respondents showed a shift towards self-determined learning behaviour in the short term, indicating a nudge toward lifelong learning behaviours, essential 21st-century attribute graduates need to succeed in their careers, given the lightning pace of change in today's technology organizations. Lastly, the study discussed several limitations that impacted its potential for replicability and recommended a more deliberate longitudinal research design for future exploration of metacognition and lifelong learning enrichment.

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A Conceptual Approach to an AI-Based Adaptive Study Support System for Individualized Higher Education

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Abstract—In the context of the digital transformation, the targeted implementation of AI-based or AI-supported technologies in "teaching & learning" as well as "administration & service" holds considerable potential for organizational change and quality enhancement for higher education institutions. The use of AI in higher education teaching and services lags behind the level in research. Therefore, holistic solutions must be planned and implemented in unity of teaching and research for the AI-based support of the stakeholders' inclusive administration, the further development or the establishment of new digital study programs and offers, and the prospective qualification of university staff in the field of AI. The solutions must be analyzed, systematized, and structured to generate a conceptual approach via an integrated architecture with adaptive services. This paper is an evolution of the concept presented at the Learning Ideas Conference 2022 and includes, in addition to explanations of the current state of the arts, the presentation of a systems-oriented approach for AI in higher education as well as the conception of the student lifecycle management at the author's university. The paper ends with the presentation of a concept regarding a decision support system for individualized studying.

Keywords—systematic approach for AI-based higher education, modular and adaptive services, individualization of studying in higher education, AI-based decision support

1 Introduction

The support of a wide variety of systems by AI will increase significantly and continuously. The many possible applications of AI are faced with immense challenges, which is why it is important to formulate and adhere to fundamental guidelines for the use of AI. The use of AI should serve to support people and not create a dominance of technology over people. AI, its possible applications, and its acceptance must be discussed in society in a broad, transparent, and comprehensive manner. In a 2018 survey by the Association of German Engineers, AI was ranked first as a leading trend in IT by 56% of respondents. Together with automation and digitization, AI is one of the three basic technologies for autonomous, smart, and adaptive systems that take on complex tasks in cooperation with humans and support them in all areas of life. AI will have a massive impact on life, education, and work processes, with AI systems serving

as assistance systems for humans and not making human performance completely obsolete. Ethics have a special place in the use of AI. The relatively high level of development of AI, especially in technology-related fields, helps to transfer application experiences regarding methodology and tools to other areas of life such as education, considering the specifics of these application fields, to push the further dissemination of AI on a professional basis [1].

With the coordination and elaboration of the global consensus on AI in education under the aegis of UNESCO, a framework with the claim of educational planning in the AI area has been created as a guide for the use of AI under the specific conditions of knowledge transfer in schools and universities in 2019 [2].

The underpinning regarding the use of information and communication technologies (ICTs) to calibrate the Sustainable Development Goal SDG4 by UNESCO's Quingdao Declaration in 2015 underscores the need to use emerging technologies to strengthen education systems, ensure access to education as well as quality and effective learning for all, and equitable and more efficient service delivery [3].

The 2019 UNESCO initiative on the application of AI in education thus serves to specify the overall UN and UNESCO sustainability and digitization goals of 2015. This finding is essential because it highlights the need to sustainably integrate AI into a general education framework, resulting in the challenge of complex solutions. The recommendations for action in the documents contain a clear message regarding a holistic and systematic approach to the use of AI in education, which among others includes [4]:

- Plan AI in education policies in response to the opportunities and challenges AI technologies bring, from a whole-government, multi-stakeholder, and inter-sectoral approach, that also allow for setting up local strategic priorities to achieve SDG 4 targets.
- Support the development of new models enabled by AI technologies for delivering education and training where the benefits clearly outweigh the risks, and use AI tools to offer lifelong learning systems which enable personalized learning anytime, anywhere, for anyone.
- Ensure AI technologies are used to empower teachers rather than replace them, and develop appropriate capacity-building programs for teachers to work alongside AI systems.
- Promote equitable and inclusive use of AI irrespective of disability, social or economic status, ethnic or cultural background, or geographical location, with a strong emphasis on gender equality, as well as to ensure ethical, transparent, and auditable uses of educational data.

To address the dynamics of transformation and the complexity of the task in using AI in education, UNESCO is pursuing further development of the approach through multiple international events that ultimately led to the launch of the AI and the Futures of Learning Project, September 30, 2021. Participants at the International Forum on AI and Education debated "Ensuring AI as a Common Good to Transform Education" in late 2021 [5].

There is also an understanding in the EU as well as in the countries of the community that AI as an emerging technology must be understood systemically and has to be integrated into all areas via complex planning, models, concepts, and implementations. Topics currently being pursued in this context include Fostering a European approach to Artificial Intelligence, Coordinating Plan on AI, up to a proposal for an Artificial Intelligence Act [6].

Experts commenting on the EU AI law proposal explicitly point out that education, just like, for example, critical infrastructure and security components, should be counted among the high-risk AI systems [7]. The high risk is derived from the complex effect of AI, which from a strategic point of view is one of the key policy areas, namely: High Performance Computing; Artificial Intelligence; Cybersecurity and Trust; Advanced Digital Skills; and Deployment and Best Use of Digital Capacities and Interoperability, listed in the context of establishing the Digital Europe Programme. Explicit reference is made to the fact that the five specific key topics are distinct but interdependent. The connection between digital transformation, which includes the application of AI, and education is made several times in the document in various relations [8]. Through the EU Commission, the integration of AI into education is linked to the updated Digital Education Action Plan [9].

2 AI penetration in higher education

Recent European University Association documents explicitly address the impact of AI in the context of technological developments. Universities are encouraged to study and assess the impact of emerging technologies and prepare graduates for labor markets that are changing due to digitization and emerging technologies, especially AI, which will also transform the mode and way of working practiced by universities and their partners [10].

The German Higher Education Forum on Digitization already took up this holistic approach in 2017 and placed AI as an emergent technology, especially in the form of machine learning, in the overall context of a digital turn for new ways of higher education in the digital age. Digital skills, digital teaching and learning, personalized learning, new understanding of roles and professions, academic program development, data security and privacy, and legal issues are mentioned as potentials and challenges for digital transformation. The focus should be on new business models; technologies; lifelong learning; internationalization; change management; organizational development; innovations in teaching, learning, and testing; curricular design; and quality development [11].

Understanding the complexity of the task means that any intervention to establish AI in existing higher education systems requires a holistic approach. Punctual or insular concepts and solutions carry the high risk that the AI deployment will not be compatible with all other processes and components and will thus be viewed as a foreign body and isolated.

The "Digital Higher Education" funding priority of the Federal Ministry of Education and Research in Germany is used to develop various topics and application

areas that are interrelated and encompass both practical knowledge for action and the development of framework conditions. The fields of application defined include experimental learning, digitized learning environments, and educational infrastructures and resources. Since 2021, the initiative "AI in Higher Education" has been funding projects ranging from the development of new study programs and modules in the AI field to the development of AI-supported systems at universities—e.g., using intelligent assistance systems or AI-based learning and examination environments. In order to do justice to the diversity and breadth of the higher education system and to achieve effective effects in studying and teaching, the following focal points are relevant [12]:

- Strengthening AI competencies in study and qualification programs.
- Improving higher education using AI.
- Sustainability, networking, and transfer between the former focal points.

Based on the described holistic approach of the use of AI in higher education, a project development for the establishment of an AI-based adaptive individualized study environment for students and university administration is currently underway, for which a conceptual design of an AI supported adaptive study system for the individualization of university services is required. Due to the complex impact of such a measure, the previous operating and process models of the university have to be analyzed, reengineered and optimized for AI support.

3 Process organization of AI-based system in higher education

Currently, many approaches to the use of AI in higher education are attempting to better address the complexity of the problem. In addition to the relatively narrow view of didactic, methodological, and/or technological nature, proposals are made that include, for example, an entire AI campus [13].

Unfortunately, they usually reflect only on the academic sphere without sufficiently including the other tangential higher education and administrative processes. Even if such a holistic approach were to be taken, massive problems of transition to upstream and downstream educational levels outside the universities would again be created in the end, which could significantly hinder the freedom to choose among educational paths for years to come. For this reason, process models have been developed that encompass complex educational pathways from school education to university training and continuing professional development. If service and administrative processes are integrated into the process models in addition to the educational pathways, the prerequisite for modeling and implementing processes and their AI support in a realistic manner is given [14].

Aspects of standardization as well as individualization of educational modules must be considered in the models. Processes can be controlled or regulated. When regulating educational processes, there are so-called feedback loops, whereby the processes can be better optimized. This approach is suitable for integrating AI support in a variety of ways. In particular, the adaptability of processes to the requirements of different

stakeholders in higher education can be significantly improved by applications of machine learning, for example. Starting from integrated educational systems, flexible systems with adaptive control and assistance for users are created.

The further digitization and automation of processes goes hand in hand in principle with data science or AI, which also applies to higher education. The use of AI has two fundamental goals: optimized and more efficient process management and user support for process operation. Assistance systems are also interesting in the field of higher education because they support users of different university groups (students, professors, and teachers as well as administrative staff) directly or indirectly in the execution of actions. They provide information and, if necessary, make suggestions for decisions and actions. With the use of AI, these processes can be upgraded. In process control, AI is currently being incorporated primarily for process data analysis, process modeling, model use (for example, for design, process analysis, and control), and process intervention, which is also transferable to AI use in higher education, including pre- and post-processes [15].

4 System-oriented approach for AI in higher education

The complexity of holistic, AI-based, and service-oriented higher education systems including the required regular adaptation and adaptivity of systems to support individualized educational pathways requires the application of complexity reduction methods. One common and proven way is system decomposition. Structurally, it means describing the higher education institution through the interaction of many components, resulting in a building block structure. The new Modular System involving AI will be the basis of individualization with simultaneous standardization and unification for the new higher education.

Higher education systems are separated from the outside world by a service layer (SL), which offers interested parties, students, lecturers, staff, and other stakeholders the opportunity to use the university's own products and services. Depending on the use case, this SL can be an interpersonal interaction facility (e.g., during advising sessions between prospective students and student administration staff) or a human-machine interface (e.g., when accessing digital learning content).

Within this layer follows the assistance layer (AL). This layer is responsible for providing the services offered by the university. In addition to administrative services, this primarily includes all services required for the proper execution of teaching and research. Basing on the AL there is an orientation layer (OL), whose purposes are:

1. the supportive provision of information for students and those interested in studying with regard to the courses of study and course content offered by the university (information layer, IL), and
2. the provisioning of a learning path layer (LPL), whose primary task is to show students the possibilities of how to connect various study modules on the way to an individual and successful degree.

The module layer (ML) following the LPL, as well as the learning unit layer (LUL) contained therein, are intended to enable students to access the individual modules and learning units and to support them in their daily tasks (see Figure 1).

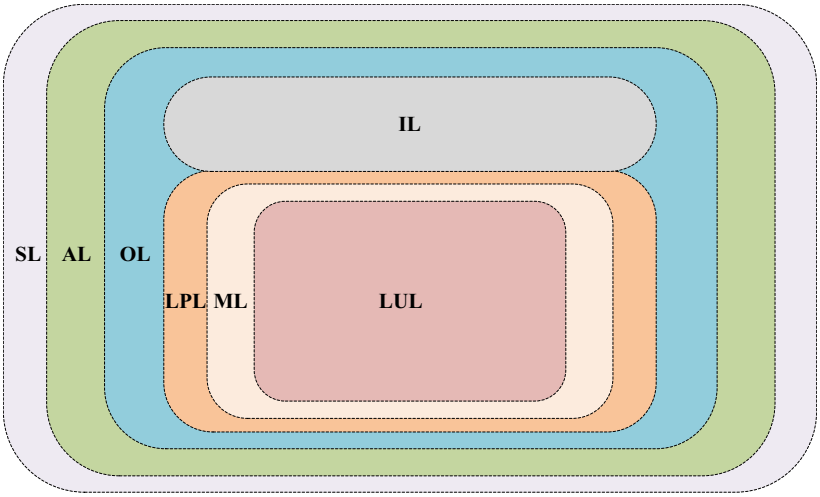

Fig. 1. Illustration of the different layers of a university

AI can be used in all of the named layers. However, a distinction must be made between the different ways in which AI can be used in institutions of higher education: as learning content within study modules, as a scientific method within research projects, and as a tool within administration. In the following, this section will focus on administrative processes, but the procedure described can be applied analogously to processes from the areas of teaching and research.

With regard to the use in administration, a further distinction must be made between the use of AI in:

1. general university administration processes, such as the administration of personnel matters or lecture rooms (SL, AL, OL, and IL),
2. student administration processes, such as AI-based decision support (SL, AL, OL, IL, and LPL), and
3. student recruitment processes (SL, AL, OL, and IL).

Users can interact with university members or the university's information systems by entering the AL via a desk. This desk can be either physical (e.g., when speaking to staff members in their physical office) or a virtual access point (when interacting with some information system). When interacting at a physical desk, the AI supports the corresponding employee working on this desk, while at a virtual desk, the AI directly supports the user.

Figure 2 shows the layers already described for service, assistance, orientation, information, and the learning paths. Within these layers exist different information

sources and their connections, represented by the circles and lines. The black circles represent the desk described. For a clearer presentation, the desk has been drawn twice, because it describes the beginning and the end of the users' interaction.

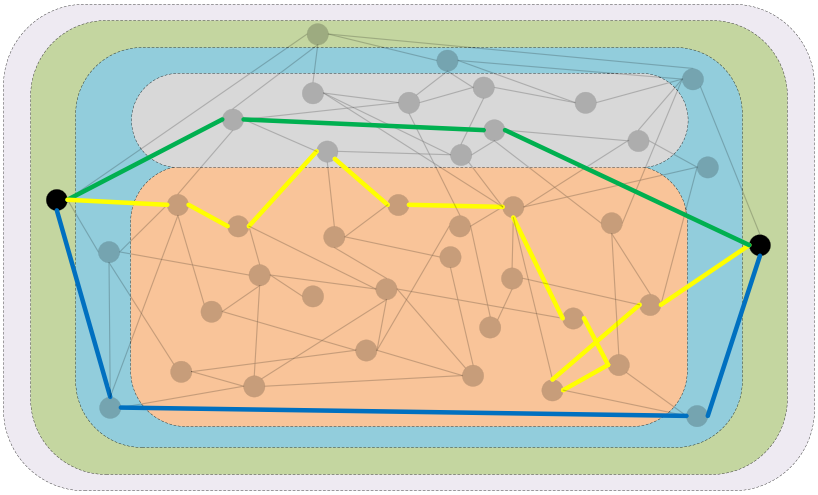

Fig. 2. Interaction possibilities of the users on administrative level

When entering a desk (either virtual or physical), the user's intention is to get some orientation, information or specific content. If the user needs some orientation (e.g., on what to study at the university), an AI-supported assistance system could be a suitable approach. In this case the following options for AI-support are possible:

1. The sematic linking of distributed information.
2. A rule-based or deep-learning-based decision support system.
3. A system, that provides speech recognition/language processing.

An example of a corresponding orientation path is shown as blue path in Figure 2. If a user is looking for information, the semantic linking of the existing, distributed information is also a possible way as well as a system with speech recognition or language processing provisioning. Figure 2 illustrates this option along the green path.

Another possibility is to support students on building their individual study path. In this regard, AI can also support by providing (semantic) linked information or by suggesting certain modules that suit the student's expectations (which have to be specified in advance) or that other students in analog situations have chosen and recommended. This process is represented by the yellow line in Figure 2. As the yellow line indicates, hybrids between the layers for orientation, information and learning paths are possible.

5 Student lifecycle management at the author's university

Student Lifecycle Management (SLcM) is the management of students throughout their lifecycle from the university's perspective. Thereby, it aims to support all (administrative) processes along the entire student journey from admission to graduation.

At the author's university the underlying basis for the student lifecycle is a circular process that aims to provide information and give orientation to the prospective and already enrolled students and thus enable them to make the best possible decisions for themselves (see Figure 3).

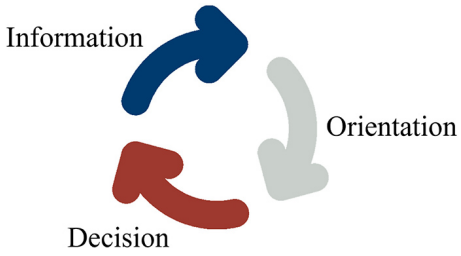

Fig. 3. The underlying basis

The actual student lifecycle at the university itself consists of three main parts: a pre-study phase, which includes all processes before the registration at the university; a study phase, which includes all processes from registration to graduation; and an alumni phase (see Figure 4).

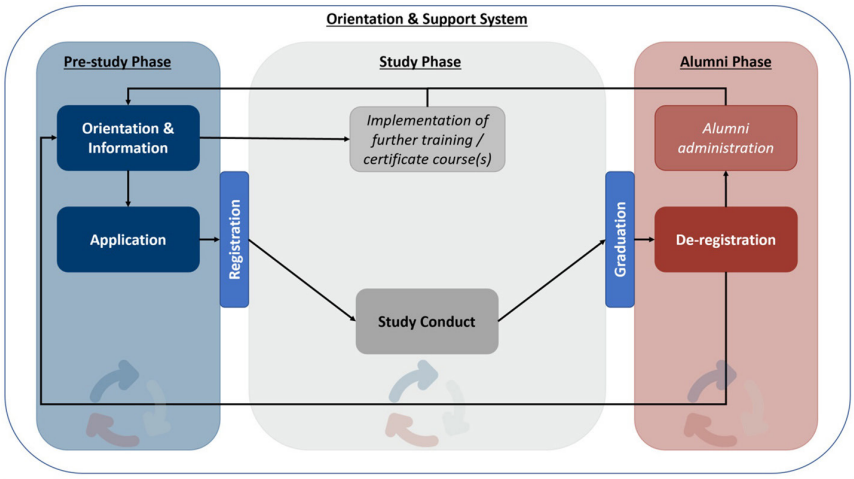

Fig. 4. Student lifecycle management at the university

For the university, the SLcM includes alumni administration and its mission of lifelong learning (by offering further training and certificate courses for non-students), because of the following goals:

- Improvement of the university's external presentation and thus potentially improvement of the image among prospective students.
- Involvement of alumni in teaching by inviting them to give lectures on corporate practice, which increases the attractiveness of teaching.
- Better corporate contacts for joint research projects with companies, whereby the results achieved in research can be directly incorporated into teaching, which in turn increases the quality of teaching.

From a student's perspective, the student lifecycle would look like the sequence of steps a student must complete on the way to graduation. This perspective has three layers: an overall administration level (blue line in Figure 5), a level for the enrolled study program (green line in Figure 5), and a sub-level for the study modules contained therein (yellow line in Figure 5). As shown in the figure, the underlying cycle of information, orientation, and decision-making forms the basis for choosing the most appropriate course of study and selecting the best possible elective modules.

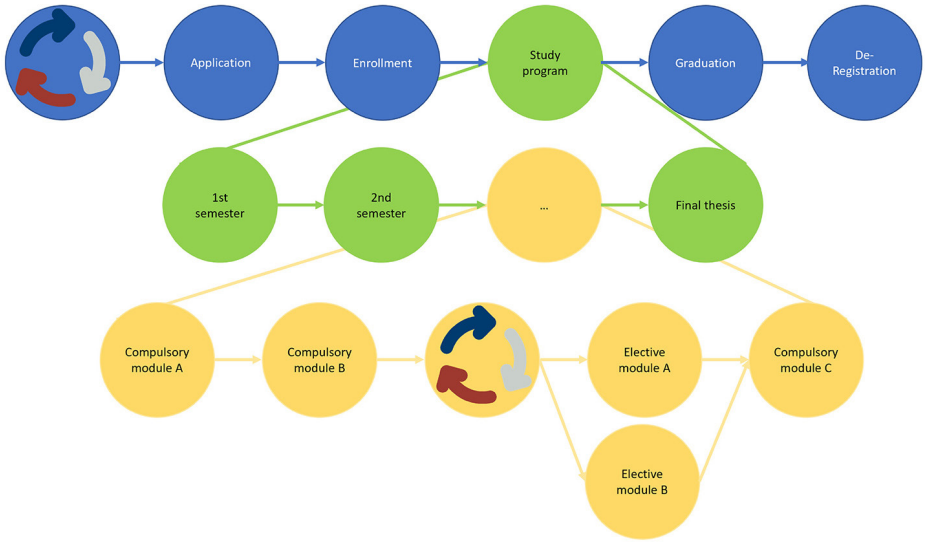

Fig. 5. Student lifecycle at the university from a student's perspective

All the parts of the university's student lifecycle and the underlying processes can additionally be supported by a holistic AI-based assistance system, which is to be implemented in the next years. This system should be usable for (prospective) students' needs as well as for the needs of the university's (teaching and administration) staff. In the following, this assistance system is described in more detail using an exemplary subtask.

6 Decision support for individualized studying

Today, young people have more opportunities than ever to choose an educational path that interests them. In Germany, more than half of all school leavers decide to study at one of the more than 420 universities [16, 17]. Prospective students can choose

from around 10,000 different undergraduate courses and almost as many graduate courses throughout Germany [18]. Accordingly, it is difficult for prospective students to find the best course of study for them from this large number of possible courses.

At the regarded university, this problem is to be addressed at least to the extent that prospective students are to be made aware of suitable courses of study simply and intuitively via the university's website by means of a decision support system. For this purpose, an AI-based dialog system for processing input on simple selection fields, but also natural language processing—a so called chat bot—is to be implemented, which is to map the following, conceptually recorded functionalities:

Students simply provide the system with some general information, such as their desired degree (Bachelor, Master, diploma) and preferred or non-preferred majors (e.g., business, languages, computer science, [mechanical or automotive] engineering, environment, health care). Based on this, the system creates a ranking, in which possible courses of study offered at the university are suggested in descending order of preference. The prospective students can then look at the corresponding course descriptions and module plans (optionally including the corresponding module contents) and compare them against each other. Once students have decided on a degree program, they click on a button "Apply for this degree program" and are automatically forwarded to the right place in the university application process. Of course, within the decision support system there is also the option of arranging a consultation at any time. In this case, the system differentiates according to the situation which advisor (central or subject-specific student advisor) can help the prospective student in a targeted manner. The according process of information, orientation and decision-making is represented in the first blue bubble in Figure 5.

In the same way, the decision support system is able to make suggestions to already enrolled students about suitable elective modules. All that is required is to specify the course of study taken, preferred or undesired specializations, and the competencies to be achieved. Based on these parameters, the system then searches through all the modules offered at the university and lists the appropriate results accordingly. Again, the according steps information, orientation and decision-making are represented in Figure 5 in the third yellow bubble.

In a second step, the system could then be expanded to the extent that it not only enables decision-making support with regard to individually optimized study paths, but that information or documents required in specific situations could also be found via the system. For example, students could ask the chat bot directly for a lecture script for one of their modules without having to manually click through the structures of a learning management system such as Moodle. Employees could use the chat bot as a central point of contact from which they can directly access the forms or documents they need (for example, to settle a business trip) without having to spend time searching for them in the university's knowledge and document base.

In the end those steps would lead to the holistic AI-based assistance system described, which would increase the user-friendliness of the university's information systems and thus lead to a better public perception of the university.

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Reshaping the Museum of Zoology in Rome by Visual Storytelling and Interactive Iconography

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Abstract—This article summarizes the concept of a new immersive and interactive setting for the Zoology Museum in Rome, Italy. The concept, co-designed with all the museum's curators, is aimed at enhancing the experiential involvement of the visitors by visual storytelling and interactive iconography. Thanks to immersive and interactive technologies designed by Centro Studi Logos, developed by Logosnet and known as e-REAL® and MirrorMe™, zoological findings and memoirs come to life and interact directly with the visitors in order to deepen their understanding, visualize stories and live experiences, and interact with the founder of the Museum (Mr. Arrigoni degli Oddi) who is now a virtualized avatar, or digital human, able to talk with the visitors. All the interactions are powered through simple hand gestures and, in a few cases, vocal inputs that transform into recognized commands from multimedia systems.

Keywords—visual storytelling, interactive iconography, digitized experience

1 A new immersive and interactive concept for the Zoology Museum in Rome

During 2021 and 2022, we designed and developed the concept of a new immersive and interactive setting for the Zoology Museum in Rome, Italy; then, we installed all the new solutions that are now part of the permanent exhibit.

The concept, co-designed with all the museum's curators, is aimed at enhancing the experiential involvement of the visitors by visual storytelling and interactive iconography. Through the promotion and organization of multimedia content, this invention is about the integration of various technologies to facilitate the use of cultural content by expanding the current exhibition space through the development of interactive solutions capable of increasing visitors' (of all ages) involvement.

Thanks to immersive and interactive technologies designed by Centro Studi Logos, developed by Logosnet and known as e-REAL® and MirrorMe™, zoological findings and memoirs come to life and interact directly with the visitors in order to deepen their understanding, visualize stories and live experiences, and interact with the founder of the Museum (Mr. Arrigoni degli Oddi) who is now a virtualized avatar, or digital human, able to talk with the visitors. All the interactions are powered through simple hand gestures and, in a few cases, vocal inputs that transform into recognized commands from multimedia systems.

Fig. 1. Initial rendering of the Arrigoni degli Oddi room with the avatar of Mr. Arrigoni, founder of the museum, within his office

Fig. 2. The interactive avatar of the museum's founder, Mr. Arrigoni degli Oddi, within his office

Fig. 3. The interactive avatar of Mr. Arrigoni in detail: he is programmed to be a talkative digital human, able to share information about his life and the history of his zoological collection both in Italian and English

To summarize, our intervention relates to

- The development of multimedia content and digital exhibits.
- The application of methodologies aimed at seeing the museum's heritage come to fruition.
- The realization of animal bones using 3D reconstructions through scanning-based technologies.
- The installation of immersive environments that allow a sensorial and gestural interaction with relevant contents.

Fig. 4. Skeletons room transformed into a hybrid reality setting: real skeletons, interactive animals (e-REAL technology) and 3D reconstructed footprints for tactile exploration

Fig. 5. A representative 3D reconstructed footprint

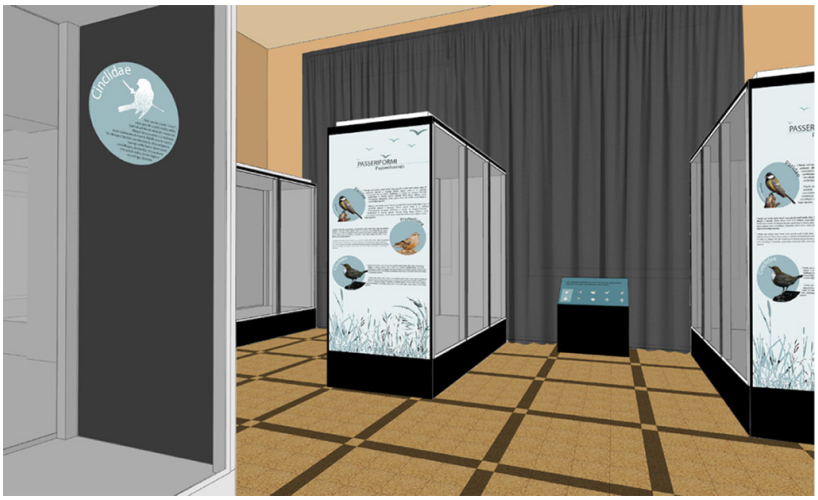

Fig. 6. Initial rendering of the birds' room: printed information, 3D animations and audio traces to recreate the sounds of the birds and to give them a new virtual life

Fig. 7. Initial rendering: Whale room transformed into a hybrid reality setting with real elements displayed jointly with a multimedia storytelling made interactive by gesture shaping (e-REAL technology)

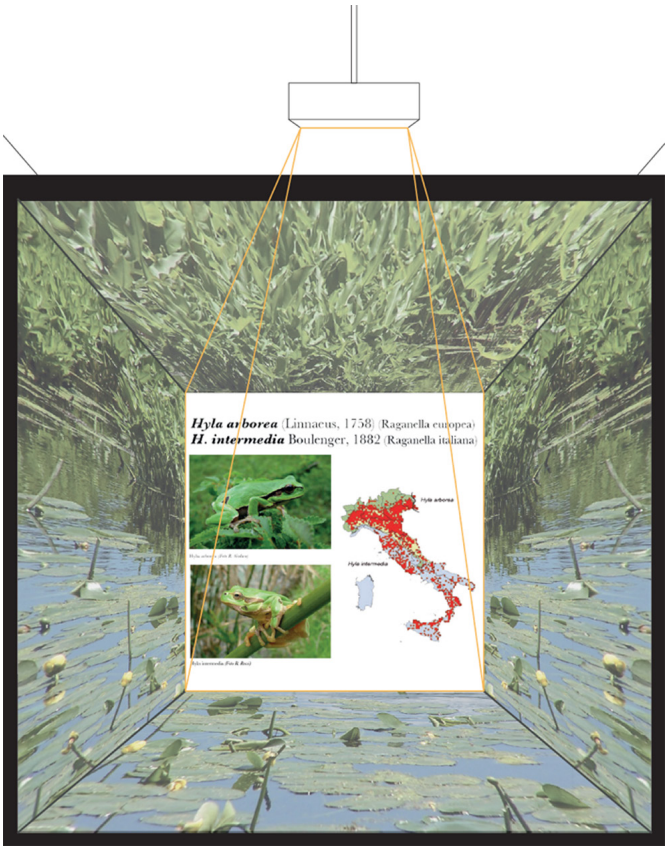

Fig. 8. Initial rendering: a fully mirrored room with 360-degree projections

Fig. 9. Augmented reality mirror (MirrorMe) to learn human evolution by mirroring the interactive skeletons of the human body and the chimpanzee

The main results are

1. Enhancement of the museum heritage, dissemination of its knowledge, and involvement of target audiences through visual and multimedia, tactile, audio, and olfactory communication tools.
2. Use of new digital media to improve the museum's offerings.
3. Improved accessibility to the museum's collection, which has increased through the promotion and organization of multimedia content.

Fig. 10. Details from the skeletons room: enhanced written and visual communication

Fig. 11. The poster introduction to the new immersive and interactive system aimed at experiential involvement and the contents' diffusion by visual storytelling and interactive iconography modalities

The entire project was made possible thanks to the contribution awarded by the European Regional Development Fund (POR FESR Lazio 2014/2020, Action 3.3.1 b), relating to the public notice *L'Impresa fa Cultura*. The contribution awarded was 181,000 euros. The total investment supported by Centro Studi Logos, an Italian company (based in Turin and Rome) from Logosnet, was 227,850 euros [1].

2 Digitalization and cultural heritage 4.0: ways of interactivity in museums and science centers

Cultural heritage is a limitless source of innovation where traditions meet cutting-edge technology, mainly from the ongoing 4.0 digital revolution. Digital heritage, as well as science museums, are very interesting domains because the contemporary audience expects both stability and flexibility from museums, which should increase their attractivity without losing credibility. Technology and exhibition design can help in the creation of new spaces and innovative solutions to grant the audience the enjoyment of a living, memorable experience.

Digitization has a primary role to play in the conservation and promotion of cultural heritage, mainly by enhancing real-life experiences, rather than replacing them. Digital is not only a way to dematerialize our cultural heritage, but—mainly if associated to visual storytelling—also a powerful way to enhance the human capacity to generate engaging content and memorable experiences [2].

Social interaction and collaboration are critical to our experience of museums and galleries. Curators, museum managers, and designers are exploring ways of enhancing interaction and in particular using tools and technologies to create new forms of participation, with and around, exhibits. It is commonly assumed that it is the exhibit that is interactive. We speak of 'interactive exhibits', 'interactive experiences', and even of 'interactives' as something that can be designed by specialists, tested rigorously, and their outcomes measured. In all these cases, it is the object that is assumed to be interactive—something that can be touched, felt, or manipulated is claimed to be more 'interactive' than something that cannot.

Interactivity is normally used to mean physical interaction with an object or exhibit—a 'hands-on' experience. Most people, when they think of interactive exhibits at all, think of the experience of the Bernouilli blower, the ball bouncing gaily on a jet of air, making soap bubbles, or making bridges out of blocks—all commonly found exhibits in today's science centers. Limiting the notion of interaction to merely physical manipulation has been challenged for years, although most proponents still consider hands-on manipulation indispensable.

Richard Gregory, founder of Britain's first hands-on science center, the Bristol Exploratory, speaks of 'minds-on' exhibits and uses illusions to show the workings of the human mind. Jorge Wagensberg, Director of the Museum de la Ciencia in Barcelona, speaks of 'hearts-on' exhibits, which he uses to describe exhibits with a large affective dimension. In these cases, interaction seems to indicate a particularly tangible engagement with the exhibit. Even so, the notion of interaction itself—whether hands, minds, or hearts-on—does not give any real indication of the quality of the experience. Interaction is too vague a term to use precisely enough to be helpful.

Physical interaction is not a prerequisite for interaction, nor is the visitor obliged to publicly interact. It is, however, no coincidence that interactive exhibits and the corresponding educational theories that place interactivity at their core, stemmed from the science center movement. Bereft of objects, science centers had as their challenge to render phenomena visible, which almost by definition involved inviting the visitor to participate in the process of creating rainbows, making waves, and mixing colors.

Moreover, the cultural discourse that would have us believe that the experience of art is unmediated, is conspicuously absent in the world of science and technology—no one pretends that a steam engine explains itself, or that a chemical reaction can be appreciated without some small understanding of what is going on.

But is all as it seems? A closer look at the science center gives quite another impression. On closer inspection, the much-vaunted interactivity often masks experiences which in fact close down the visitor's ability to explore, and limit the ways in which they can direct their own discovery.

What if we started to look at interactivity as the property of the visitor and not of the exhibit? What if we looked at the exhibit as a tool that, if properly conceived, conferred the property of interactivity onto its user? What would this interactivity look like? Is interaction different in museums of fine art compared to those of applied art or design? We would have to answer, no. The nature of the engagement in any informal setting is potentially the same, subject to the way in which the museum chooses the user-languages it employs and the degree to which the museum reduces the barriers that prevent the user from engaging with the material.

Where museums do differ, however, is in their deliberate use—or avoidance—of specific user-languages. Science centers were among the first to be forced to explore the user-languages of observation and variables, as both are proper to the natural sciences. Given their history, they were also among the first to explore the user-languages of problems and games. This is not to say, however, that fine art museums cannot make equally good use of these user-languages. Joaneath Spicer at the Walters Art Gallery in Baltimore, Maryland, turned her entire museum into a resource to solve an art historical puzzle and the new British Galleries at the Victoria and Albert are rich in exhibits which employ the user-languages of puzzles and games.

What is important, we believe, is not the nature of the museum's content, but the degree to which we make explicit use of particular user-languages in order to actively engage our visitors in the pleasure that comes from actively exploring and constructing the world in which we live in all its variety [3, 4]. All the above considerations are part of the vision behind our concept for the Museum of Zoology in Rome.

3 Digital technology for knowledge, design and experiential education for culture

The learning society represents a new human condition linked to contemporary social phenomena, a society where men and women live, work, organize themselves and utilize know-how and knowledge as a new form of capital. This vision lays the structural foundation for economics and social development: starting from Donald Schon's paradigm, 'learning, reflection and change' is translated into the promotion of

creativity at all levels, addressing a critical and civic awareness and inducing a process of social change.

Design, considered as a whole set of disciplines in the universe of industrial design, deals with designing the value of processes, goods, environments and services, of increasing it and imparting this to society and citizens. Experiential design proposes a system of mediation between the territorial context and the cultural heritage system or the widespread heritage (memory, history, landscape) and the reference community intended as the final user. This makes it possible to have multiple forms of representation of goods and legitimizes their differentiated values, access, use and appropriation, whether directly or by using technology. Bearing this vision in mind, design does not solely restrict itself to designing the experience of use of goods (economy of experience) but also introduces an innovative vision of systems and a shared vision of cultural heritage in all its forms; it also makes it possible to start upon a participatory and inclusive learning path and social well-being, which makes its diffusion in the community sustainable and cost-effective (from the institution to the cultural operator, to the different categories of users).

The service economy in recent years has shown considerable potential by creating an innovative system with a social nature, based on a particular type of economic performance. Goods and services are no longer sufficient as economic products; a new need has been created: through a design process, an integrated fruition project can be created, that is to say, the words, giving a sensorial and psychological form to experience.

Knowledge technologies are recognized as opportunities in terms of conservation, study and communication of heritage, but also of creating culture and awareness that is expressed in the contemporary forms of sharing and dissemination. Learning, in the different seasons of life, should therefore be considered as the source of an increasingly innovative economy that becomes sustainable and has an impact if it reaches a substantial and diversified number of users and social subjects.

Design for cultural heritage includes theories, methodologies, and enhancement techniques that have the cultural heritage system understood in its cognitive, social and symbolic dimensions as their application sphere. The disciplines of representation interact with the multiple disciplinary specializations of design, proposing the definition of interpretative models for the analysis and representation of the historical, cultural, aesthetic, and environmental values of a cultural asset as well as its material and immaterial meaning. The value enhancement strategy produces advanced visualizations as well as computer and multimedia modelling. Moreover, the experiential value, with its emotional imprint and fruition, is emphasized through immersive and interactive technologies. The applications make it possible to have a structured and flexible knowledge process including the simulation of forms of innovation and an increase in the social value of the transmission and sharing of cultural contents. In fact, in order to fulfil their educational mission, the spaces of culture need to go beyond the tangible and common sensorial dimensions in order to communicate and share a heritage, understood also as a process of appropriation and as such also linked to the intangible dimension. It is in this direction that the Convention for the Protection of Intangible Cultural Heritage (Paris, 2003) goes. It defines the intangible cultural heritage as ‘the practices, representations, expressions, knowledge, skills—as well as the instruments,

objects, artefacts and cultural spaces associated therewith—that communities, groups and, in some cases, individuals recognize as part of their cultural heritage'.

Within the framework of UNESCO, there is the Recommendation Concerning the Protection and Promotion of Museums and Collections, Their Diversity and Their Role in Society (Paris, 2015), which underscores the importance of technologies in assisting museums in their task of educating and encouraging continuous learning. Technologies are therefore changing the relationship between users and cultural content in museums, libraries, and places of learning. The environments must be imagined and transformed by also considering their virtual extension and allowing a range of customizations linked to the selection of contents. Participation and sharing mediated by the user can also create new cultural content by blazing a path to new forms of active and participatory learning. Among the cultural actions that are related to new media and their language, the creation and sharing of information and knowledge are included, as well as the accessibility to heritage through digital artefacts that represent ideas, identities and values of belonging. To these, Manovich also adds the interactive cultural experience, the opportunity to enjoy the experiences and cultural products by visitors, as well as ways to recreate the displayed objects, textual, vocal and/or visual communication and participation in a type of information that 'ecologically' regenerates knowledge and its diffusion. Knowledge technologies offer multiple opportunities and challenges to cultural and scientific practitioners; the challenge of involvement and experience is not only one of technology and design, but also, and perhaps more importantly, a mental and imaginative one [5].

4 The instructional design for the Museum of Zoology in Rome

The instructional design for the Museum of Zoology in Rome is summarized by 3 key words: visualization, interaction, immersion. An effective visualization is the key to help untangle complexity: the visualization of information enables visitors—that are learners—to gain insight and understanding quickly and efficiently. Examples of such visual formats include sketches, diagrams, images, objects, interactive visualizations, information visualization applications, and imaginary visualizations such as in stories. In such a way, visualizations show relationships between topics, activate involvement, generate questions that learners didn't think of before and facilitate memory retention. So visualizations act like concept maps to help organize and represent knowledge on a subject in an effective way.

Half of human brain is devoted directly or indirectly to vision and images are able to grab our attention easily. Human beings process images very quickly: average people process visuals 60,000 times faster than text. This is why we, as humans, are confronted with an immense amount of images and visual representations every day: digital screens, advertisements, messages, information charts, maps, signs, video, progress bars, diagrams, illustrations, etc. If we have to warn people, symbols and images are excellent: they communicate faster than words and can be understood by audiences of different ages, cultures and languages. Images are powerful: people tend to remember about 10% of what they hear, about 20% of what they read and about 80% of what they see and do [6].

Mainly the e-REAL and the MirrorMe technologies submerge learners in an immersive and interactive reality. Multi-surface environments, like the ones we created within the museum's rooms involved by our intervention, require users to be 'physically' engaged in the interaction and afford physical actions like pointing to a distant object with the hand or walking towards a large display to see more details. Based on a body-centric paradigm, the e-REAL setting is well adapted to device- or eyes-free interaction techniques because they account for the role of the body in the interactive environment.

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The GW Mobile Learning Center: Mixed-Reality within an Immersive and Interactive Learning Setting

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Abstract—The Community Medi-Corps Program—designed and implemented by the George Washington University (GW) School of Medicine and Health Sciences (SMHS) faculty with Growth and Opportunity Virginia funding (GO Virginia)—is aimed at leveraging the power of community, educational institutions, mentors, industry, and business partners to close the opportunity gap, transform student learning, and enrich the regional workforce. This program transforms educational experience through innovative virtual reality, augmented reality, and a mix between the two that is the enhanced reality (e-REAL). Students will be better prepared in the pathways they choose for high demand health and life sciences industry jobs that will help grow the economy.

Keywords—immersive experience, interactive visualization, STEM education

1 The Community Medi-Corps program

Talent is everywhere, but opportunity is not. The Community Medi-Corps Program—designed and implemented by the George Washington University (GW) School of Medicine and Health Sciences (SMHS) faculty with Growth and Opportunity Virginia funding (GO Virginia)—is aimed at leveraging the power of community, educational institutions, mentors, industry, and business partners to close the opportunity gap, transform student learning, and enrich the regional workforce.

The Community Medi-Corps Program (Medi-Corps) is a $1.6 million project made possible by a $700,000 grant from GO Virginia. The program will augment curriculums and enhance health sciences education in the Alexandria City (Virginia) Public Schools (ACPS), Arlington (Virginia) Public Schools (APS), Fairfax County (Virginia) Public Schools (FCPS), and Loudoun County (Virginia) Public Schools (LCPS) The centerpiece of Medi-Corps is a mobile Immersive Learning Center (ILC)—a 45-foot-long classroom/lab on wheels that provides students with cutting-edge technology, simulation, and immersive virtual reality and augmented learning experiences [1].

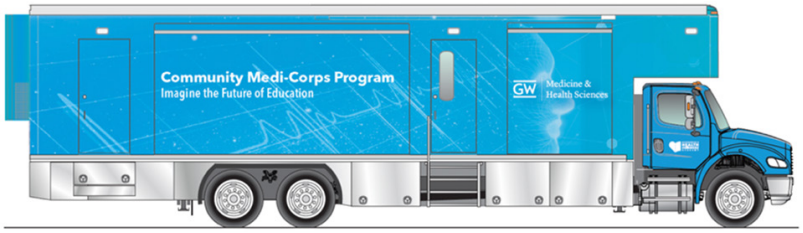


Fig. 1. Rendering of the mobile immersive learning center

Fig. 2. Internal view of the mobile immersive learning center

Fig. 3. Another perspective on the mobile immersive learning center

Medi-Corps and the ILC allow students to engage and work together to problem-solve, use virtual technology, and interact with experts in the life and health science fields. Faculty and staff members from SMHS and the four partnering school systems are supporting the project. The ILC incorporates the latest immersive learning technologies to support critical thinking and applied learning, and to maximize student learning and engagement. Our vision is for this initiative to serve as a best practice for other areas in Virginia and the region. We feel strongly that this innovative model, linking secondary education and four-year institutions, will benefit students in numerous ways and better prepare them in health sciences.

Although virtual reality (VR), augmented reality (AR), and mixed reality (MR) simulation training has gained prominence, review studies to inform instructors and educators on the use of these technologies—usually grouped under the name of extended reality (XR)—in science, technology, engineering, and mathematics (STEM) are still scarce. We found interesting references in Pellas, Dengel and Christopulos that analyzed various VR-supported instructional design practices in K-12 (primary and secondary), as well as higher education, in terms of participants' characteristics, methodological features, and pedagogical uses in alignment with applications, technological equipment, and instructional design strategies [2]. For the design of both the mobile ILC and the learning experiences, we decided to implement the guidelines from Salvetti, Bertagni, Wieman, Waldrop, and Brenner that are summarized by the title of the book Learning 4.0: Advanced simulation, immersive experiences, flipped classrooms, mentoring and coaching [3].

Fig. 4. An e-REAL interactive content: virtual patient

Our project emerges from a large-scale collaborative effort supported by a large number of professionals and institutions. Our colleagues provided support for this initiative at multiple levels. The commonly shared goal is to inspire youth to explore and connect as we create tomorrow's next generation of health sciences leaders.

Students are expected to be able to engage and collaborate, thanks to state-of-the art opportunities for students to learn STEM-H subjects interactively.

The Medi-Corps program is aimed at further bridging the gap between academics and the workforce by offering internships and mentorships with experienced health professionals.

The Medi-Corps team envisions the project to serve as a best practice that can be replicated in other areas in Virginia and the region. The innovative model, linking secondary education, community colleges, and four-year institutions, will benefit students in numerous ways and better prepare our future workforce in health sciences.

Medi-Corps is based at the Governor's Health Sciences Academy (Academy) at Alexandria City High School. Academy, APS, FCPS, and LCPS students are expected to experience interactive learning in the ILC, starting in the 2022–23 school year. Community events that showcase immersive learning and opportunities in the health and life sciences fields are also planned.

2 The mobile immersive learning center and the vision behind the program

The ILC was designed by the GW SMHS Community Medi-Corps grant team in collaboration with LifeLine Mobile, a vendor from Columbus, Ohio, and with the Logosnet Instructional Design Team, and the e-REAL Technology Team. The ILC features a 45-foot mobile immersive learning center that bridges the gap between the classroom and the field.

Fig. 5. Exterior view of the mobile immersive learning center

The ILC transforms educational experience through innovative virtual reality, augmented reality, and a mix between the two that is the enhanced reality (e-REAL). It raises student aspirations and attracts students to postsecondary education, provides summer programs, job fairs, and community outreach events.

The main issues addressed by the Medi-Corps Program are:

- Limited diversity in the life sciences and health professions workforce has significant consequences for access to health care services, health outcomes, and health equity, especially for underrepresented minority patients and underserved communities.
- Youth who identify as racial or ethnic minorities are less likely to be exposed to and less prepared for a range of STEM-H careers.

A long-term demand exists for skilled and credentialed health and life science workers: the field is growing at a faster rate than others with 7–26 percent growth forecast through 2028.

The Community Medi-Corps program strives to:

- Provide summer programs, job fairs, and community outreach events.
- Engage professionals in STEM-H fields to serve as student mentors.
- Shape future leaders essential for a healthier society.
- Champion equitable excellence and robust academic opportunities.
- Enrich the diverse communities it serves.
- Promote equity, diversity, and inclusion in practice.
- Influence future workforce needs for high demand jobs.
- Contribute to the region's economic growth and resilience.

To learn more about the program and the STEM mobile lab please view this video: https://youtu.be/1UL51zFq_bM.

Experts in postsecondary education agree that the center can provide students with hands-on learning experiences and encourage them to stay in STEM and health care fields after graduation.

According to William Corrin—the director of K-12 education at MDRC, an organization that researches social policy—high school and university partnerships are beneficial because they smooth the transition for students, making it less of a gap and more of a bridge. "Those transition points are usually the places where there's the greatest risk for students to experience some kind of disruption to their educational trajectory," Corrin said.

Max Milder, the director of research at EAB, an education research organization, said partnerships between higher education institutions and high schools can create a pipeline of leading new students to the institution. "Universities are always interested in how they're going to continue to attract future students or enrollments in the coming years," Milder said. "There's a part of this that is getting George Washington University in front of high school students as early as possible, even before they're going into that decision-making process for enrollment."

Milder said exposing high school students to high-level technology that is common in medical education familiarizes students with what they'll be using throughout their medical careers. "Experiential learning is really critical," he said. "And that's true in K-12. That's true in higher education as well. And so part of the effort here is to bring some of these scientific or medical concepts to life and do so in a way that is really engaging and hopefully fun for the students as well" [3].

The most innovative virtual, augmented, and mixed reality technologies are on board into the mobile ILC. Reality in the digital age is becoming more and more virtual, augmented, and mixed. These technologies offer options to improve learning methods. Sharing and mixing up the latest trends from digitization and virtualization, neurosciences, artificial intelligence, and advanced simulation allows us to establish a new paradigm for STEM-H education.

3 The learning setting and the main educational outputs

The learning setting of the mobile Immersive Learning Center is designed according to the STEAM approach: It's the extension of an acronym that originally stands for science, technology, engineering and math, with the arts added because STEM alone misses several key components that many employers, educators, and parents have voiced as critical to thrive in the present and rapidly approaching future. The STEAM approach refers to a movement that has been taking root over the past several years and is surging forward as a positive mode of action to truly meet the needs of a 21st century society.

STEAM uses science, technology, engineering, the arts and mathematics as access points for guiding learner inquiry, dialogue, and critical thinking. The end results are learners who take thoughtful risks, engage in experiential learning, persist in problem-solving, embrace collaboration, and work through the creative process. STEAM is a way to take the benefits of STEM and complete the package by integrating these principles in and through the arts. STEAM takes STEM to the next level: it allows learners to connect their learning in these critical areas together with arts practices, elements, design principles and standards to provide the whole pallet of learning at their disposal. STEAM removes limitations and replaces them with wonder, critique, inquiry, and innovation [5].

Designing a program that includes active learning requires more content knowledge, not less, than teaching in the classic lecture mode. If a teacher uses active learning techniques, they are still telling students information, but it's in response to their questions, their needs to solve a problem, and so they learn much more from it [6]. So, a teacher has to work hard to use active learning in the class and has to carefully structure problems and activities to get students to think like a scientist, mathematician, or, in our case, as a healthcare professional.

In active learning methods, students are spending a significant fraction of the time on activities that require them to be actively processing and applying information in a variety of ways, such as answering questions using electronic clickers, completing worksheet exercises and discussing, and solving problems with fellow students. The instructor designs the questions and activities and provides follow-up guidance and instruction based on student results and questions. Also, good active learning tasks simulate authentic problem solving and therefore teaching with these methods typically demands more instructor subject expertise than does a lecture [7].

The setting of the mobile Immersive Learning Center is designed around 3 key-words: visualization, interaction, immersion. It is a fully immersive and multitasking environment, designed to present challenging situations in a group setting, engaging

all participants simultaneously. The e-REAL instructional design and technology make possible teaching and learning with motion pictures, as well as with 3D visualizations and augmented reality tools. These tools are fully interactive and "talkative"; avatars or digital humans are a key-component of the setting.

Effective visualization is the key to help untangle complexity: the visualization of information enables learners to gain insight and understanding quickly and efficiently. Examples of such visual formats include sketches, diagrams, images, objects, interactive visualizations, information visualization applications, and imaginary visualizations in scenarios [8]. Visualizations within e-REAL show relationships between topics, activate involvement, generate questions that learners didn't think of before, and facilitate memory retention. So visualizations act concept maps to help organize and represent knowledge on a subject in an effective way.

Half of the human brain is devoted directly or indirectly to vision, and images are able to grab our attention easily. Humans process images very quickly: on average, a person processes visuals 60,000 times faster than text. This is why we, as humans, are confronted with an immense amount of images and visual representations every day: digital screens, advertisements, messages, information charts, maps, signs, video, progress bars, diagrams, illustrations, etc. If we have to warn people, symbols and images are excellent: they communicate faster than words and can be understood by audiences of different ages, cultures, and languages. Images are powerful: people tend to remember about 10% of what they hear, about 20% of what they read, and about 80% of what they see and do [9].

Also, contextual factors have tremendous importance because they are key to learning. Learners practice handling realistic situations, rather than learning facts or techniques out of context. Context means "related factors" that can be influential and even disruptive. The most effective learning occurs through being immersed in context. Experience is lived and perceived as a focal point and as a key crossroad [10]. Much like being immersed within a videogame, people are challenged by facing real cases within complex scenarios that present a more than real wealth of information. This is because the many levels of the situation are made available simultaneously, by overlaying multisource information on the projected walls and inside a number of augmented reality displays made available within the setting.

The e-REAL setting and technology submerges learners in an immersive reality where the challenge at hand is created by sophisticated, interactive computer animation in three dimensions and holographic projections. Multi-surface environments require users to be "physically" engaged in the interaction and afford physical actions like pointing to a distant object with the hand or walking toward a large display to see more details. Based on a body-centric paradigm, the e-REAL setting is well-adapted to device- or eyes-free interaction techniques because they account for the role of the body in the interactive environment. Very large interactive wall displays do not lend themselves to use with traditional interaction modalities such as mice and keyboards. It is a multi-surface environment that encourages users to interact while standing or walking, using their hands to manipulate objects on multiple displays. Within the e-REAL setting, the body itself is used for input: Users can interact by moving the body, or with a flick of the hands and some other gesture [11–13].

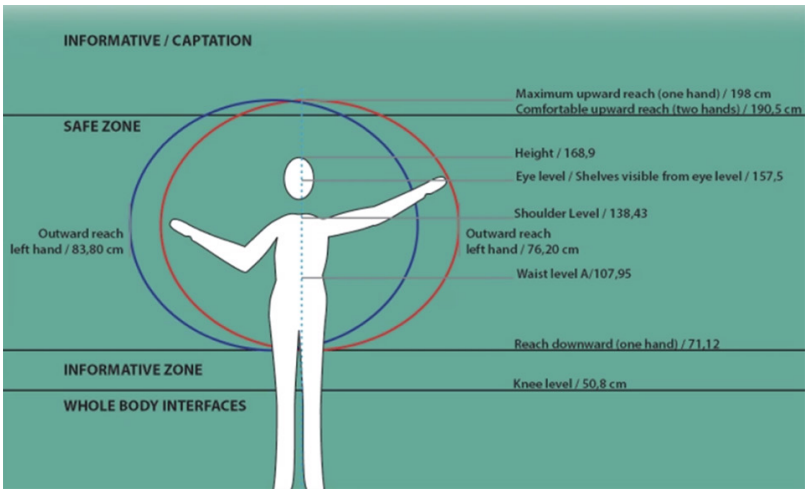


Fig. 6. Ergonomic reference table for e-REAL gesture shaping and body interaction

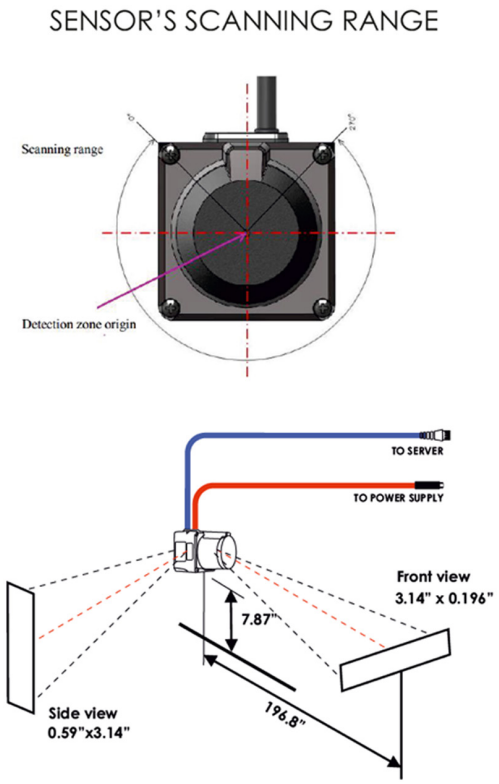
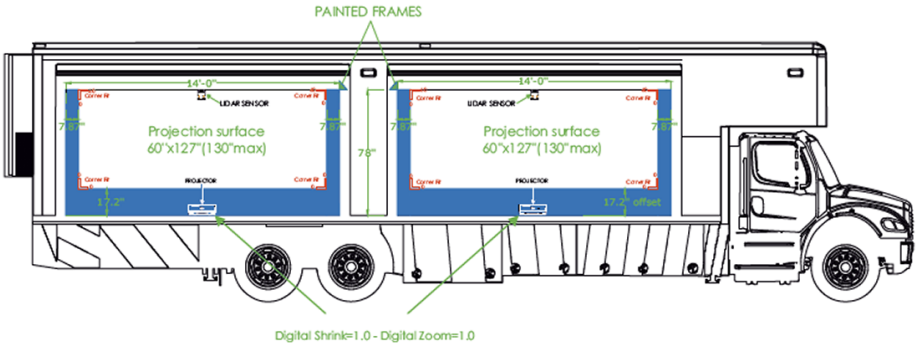


Fig. 7. The e-REAL sensor enabling gesture shaping and body interaction



- Projection rapport: 16:9
- Projection surface: 60"x127"-130"
- Projection area will be surrounded, onto the same wall, by a frame painted like the side walls
- Projectors' settings (Corner Fit, Digital Shrink and Zoom) are displayed into the above image.
- Projections' height from the floor is expected to be 85'': the visible projection's height will be reduced to 78'' from the floor by an electronic "black strip" with parametrized height (approx 7''), adjustable at runtime.

Please notice that there is a 3% tolerance regarding projection's expected performance, due to optical component variations. It is recommended to physically test the projection size and distance before permanently installing the projector.

Fig. 8. Projection surfaces and details about the e-REAL immersive setting

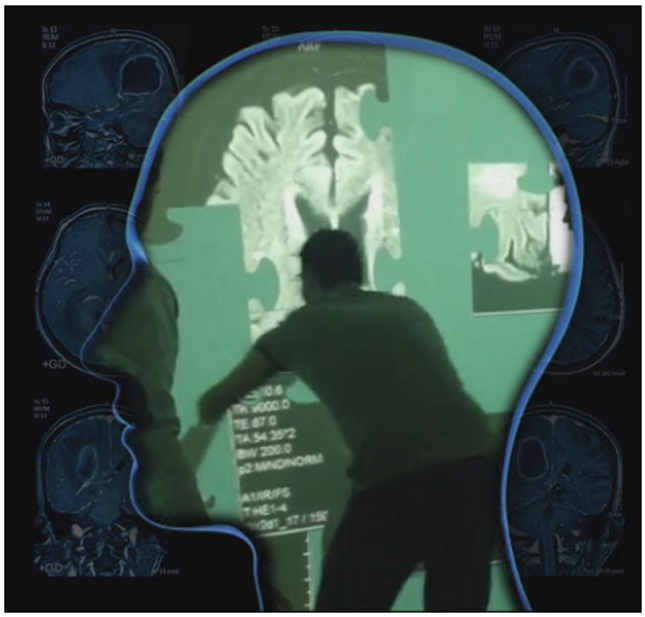


Fig. 9. A learner facing an e-REAL interactive image showing a brain cancer, divided in 8 pieces, during an experiment aimed at determining whether cognitive retention improves when visualization is broken into multiple smaller fragments first and then recomposed to form the big picture

Using the body enhances both learning and reasoning and this interaction paradigm has proven effective for gaming [14], in immersive environments [15], when controlling multimedia dance performances [16] and even for skilled, hands-free tasks such as surgery or emergency medicine [17]. Smartphones and devices such as Nintendo's Wii permit such interaction via a hand-held device, allowing sophisticated control. However, holding a device is tiring [18] and limits the range of gestures for communicating with co-located users, with a corresponding negative impact on thought, understanding, and creativity [19].

Advances in sensor and actuator technologies have produced a combinatorial explosion of options that do not require hand-held devices. The e-REAL interaction design team, since 2011, has tested and selected various options in order to combine them in a coherent, powerful way based on specific guidelines (like the ones displayed in Figure 6). A few simple and intuitive gesture options are the solution, enabling the learning experiences within the mobile Immersive Learning Center. In such a way, learners are physically engaged in the interaction and afford physical actions like pointing to a distant object with the hand or walking toward a large display to see more details [20], listening to and interacting with one or more digital humans.

Fig. 10. e-REAL representative avatars programmed to perform as digital twins of the learning facilitators

Fig. 11. e-REAL representative digital human, programmed to perform as an athlete student expected to be injured and to start a healthcare rehabilitation program

Fig. 12. e-REAL avatar programmed to perform as an injured lady, able to call for help and to interact dialogically with learners and simulation instructors

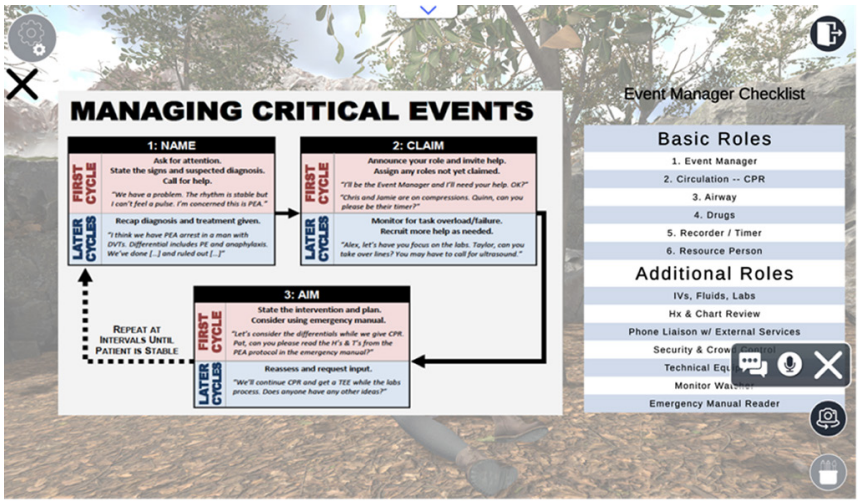


Fig. 13. Name-Claim-Aim©: A mnemonic and checklist developed by faculty at the center for medical simulation (Boston, Massachusetts), that encompasses a strategy to help health care professionals effectively organize a team for managing critical clinical events

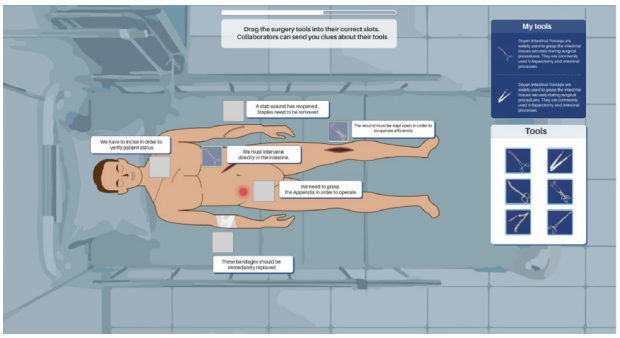


Fig. 14. e-REAL representative gamified healthcare activity designed to challenge the learners with a cooperative game aimed at understanding selected surgical procedures and to place surgery tools in the correct slots

The e-REAL learning setting encourages students to learn by doing with the help of simulation or game-based tools. This setting allows learners to experience abstract concepts in three-dimensional space based on visualization, enhancing at the same time an active learning mindset by encouraging cooperative work among students. Visual storytelling techniques are essential to represent a realistic context where learners are proactively involved to analyze scenarios and events, to face technical issues, to solve problems. The most effective learning occurs when being immersed in a context: realistic experience is lived and perceived as a focal point and as a crossroad [21].

A context related experience within an e-REAL setting is similar to being immersed within a video game with our entire bodies. Characteristics of games that facilitate

immersion can be grouped into two general categories: those that create a rich mental model of the game environment and those that create consistency between the things in that environment. The richness of the mental model relates to the completeness of multiple channels of sensory information, meaning the more those senses work in alignment, the better. The richness also depends on having a cognitively demanding environment and a strong and interesting narrative. A bird flying overhead is good. Hearing it screech is better.

Cognitively demanding environments in which players must focus on what's going on in the game will occupy mental resources. The richness of the mental model is good for immersion because if brain power is allocated to understanding or navigating the world, it's not free to notice all of its problems or shortcomings that would otherwise remind them that they're playing a game. Finally, good stories—with interesting narratives, credible because intrinsically congruent as much as possible—attract attention to the game and make the world seem more believable. They also tie up those mental resources. Turning to game traits related to consistency, believable scenarios, and behaviors in the game world means that virtual characters, objects, and other creatures in the game world behave in the way in which learners expect.

The process of learning by doing within an immersive setting, based on knowledge visualization using interactive surfaces, leaves the learners with a memorable experience. From an educational perspective, learners are not assumed to be passive recipients and repeaters of information but individuals who take responsibility for their own learning. The trainer functions, not as the sole source of wisdom and knowledge, but more as a coach or mentor, whose task is to help them acquire the desired knowledge and skills. A significant trend in education in the 19th and 20th centuries was standardization. In contrast, in the 21st century, visualization, interaction, customization, gamification, and flipped learning are relevant trends. In a regular flipped-learning process, students are exposed to video lectures, collaborate in online discussions, or carry out research on their own time, while engaging in concepts in the classroom with the guidance of a mentor. Critics argue that the flipped-learning model has some drawbacks for both learners and trainers. A number of criticisms have been discussed with a focus on the circumstance that flipped learning is based mainly on video-lectures that may facilitate a passive and uncritical attitude towards learning, in a similar way to didactic face-to-face lectures, without encouraging dialogue and questioning—within a traditional classroom.

The e-REAL setting is a further evolution of a flipped classroom, based on a constructivist approach. Constructivism is not a specific pedagogy, but rather a psychological paradigm that suggests that humans construct knowledge and meaning from their experiences. From our constructivist point of view, knowledge is mainly the product of personal and interpersonal exchange. Knowledge is constructed within the context of a person's actions, so it is "situated": it develops in dialogic and interpersonal terms through forms of collaboration and social negotiation. Significant knowledge—and know-how—is the result of the link between abstraction and concrete behaviors.

Knowledge and action can be considered as one: facts, information, descriptions, skills, know-how and competence—acquired through experience, education and training. Knowledge is a multifaceted asset: implicit, explicit, informal, systematic, practical, theoretical, theory-laden, partial, situated, scientific, based on experience

and experiments, personal, shared, repeatable, adaptable, compliant with socio-professional and epistemic principles, observable, metaphorical, and linguistically mediated. Knowledge is a fluid notion and a dynamic process, involving complex cognitive and emotional elements for both its acquisition and use: perception, communication, association, and reasoning. In the end, knowledge derives from minds at work. Knowledge is socially constructed, so learning is a process of social action and engagement involving ways of thinking, doing and communicating [22].

The Community Medi-Corps Program is currently at its beginning and we will be able to research for and analyze its educational inputs in the coming years. So far, we can say that the program's first execution into the mobile Immersive Learning Center is reaching the expected outcomes.

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