

Application of Adult Learning Theory to STEM Education in Online Learning Environment

1st Stefan Kleinke

Department of Graduate Studies
Embry-Riddle Aeronautical University, Worldwide
Daytona Beach, USA
kleinkes@erau.edu

2nd Yuetong Lin

Department of Engineering and Technology
Embry-Riddle Aeronautical University, Worldwide
Daytona Beach, USA
Yuetong.Lin@erau.edu

Abstract—In this work-in-progress paper, we will discuss the implications of adult learning theory (ALT) for science, technology, engineering, and math (STEM) education in fully online, distributed learning environment. Current approaches in online STEM education are grounded in a constructivist view of learning and based on the concept that students are active participants in their knowledge creation. We will re-examine these premises in the context of new findings and current developments in higher education landscape. More specifically, the increase in non-traditional and adult students using online platform to continue their education has presented a new challenge for learning activity design, development and delivery. ALT can be extended to the existing practices to help build greater process- and progress-oriented as well as individualized learning approaches. In this paper we will focus on reviewing the general ALT ideas and their potential for revamping online STEM education. The detail recommendations will be proposed in the next phase of the study.

Index Terms—Adult learning theory, online STEM education

I. INTRODUCTION

The increasing popularity of online learning models coupled with recent societal and economic developments has fundamentally changed the characteristics of student population in higher education. While the traditional division between face-to-face and online education has further eroded, it is especially in the online environment in which an accelerated diversification of the student body has become evident [1]–[3]. Thus, no longer does a one-size-fits-all approach to learning activity, design and delivery seem appropriate or effective. At the same time, professional demand for higher education has increased and an expanding global footprint of universities, coupled with intensifying economic pressure, has resulted in further desire to mass-produce learning [4]. Consequently, online education seems to face a paradox. On one hand it is expected to provide meaningful and relevant adult learning experiences through individualized learner-centric approaches (i.e., to fulfill the identified needs), on the other hand it is being utilized as force-multipliers in a global higher education industry. This conflict provides the context for this research and its suggestions for improvements in the next phase.

II. CHANGING HIGHER EDUCATION LANDSCAPE

We are at an exciting crossroad in education and in our society as a whole because, never before in history was knowledge and information so easily accessible as today. With

the rise of the information age, the internet, and the associated technologies, our collectively existing human knowledge is available at our fingertips, at any time and from anywhere, even on the go. If previously studying required physical infrastructures and resources, heavy books, long library visits, and attendance of firmly scheduled events, learning in our networked world virtually requires nothing more than access to a device with internet connection at a place and time of our choosing.

A. Changing Focus

To cope with this changing environment, education though already has, will have to adapt further. While knowledge accumulation may have been at the center of schooling in the 20th century, preparation for 21st century academic and professional expectations requires the development of skills to manage the abundance of available information and utilize it in a task-oriented way to solve real-world-relevant problems [5]. In other words, the focus has shifted from the acquisition and retention of knowledge towards its transferability into new contexts, and empowering students with life-long learning skills and attitudes such as the ability to think analytically and critically or solve problems collaboratively.

B. Changing Instructor Roles

This fundamental change in the philosophy about education also requires a paradigm shift in the role of instructors. Consistent with the social-constructivist idea that all knowledge is actively created by the learners through their discourse [6]–[11], the main function of teaching has shifted from one of transmission of knowledge to one of facilitation of learning through dialog and collaboration [11]–[14], in which the instructor is neither required nor expected to know everything. In our vastly interconnected environment in which a multitude of expert perspectives is effortlessly accessible from anywhere at any time, students are no longer dependent on the instructor as the “more-knowledgeable other” [15], [16] and their only pathway to more knowledge. Furthermore, the new orientation of learning on personal and professional needs and interests relevant to the students makes it virtually impossible that any individual instructor can provide all the required knowledge

to solve these very specific problems. Thus, working with and reliance on external resources for inquiry becomes paramount.

However, that does not necessarily have to mean that, in the future, faculty will be obsolete. Quite contrary, one could argue that the multiple roles assumed by a facilitator during these constructivist learning processes require even more teaching presence, possibly necessitating an entire instructional team, and constitute a new form of Vygotski's "more-knowledgeable other", one in which teachers model the knowledge, skills, and attitudes required to efficiently obtain pertinent information, critically analyze it, and proficiently synthesize it into authentic decision and solution processes. Such needs for mentorship and guidance across all three domains of learning (i.e., cognitive, affective, and behavioral) by far, seem to exceed the traditional demands of the singular knowledge-transmission role in teaching. In a sense, instructors will have to become "more-competent others", and be willing to continuously enhance their pedagogical and technical skill-sets in addition to any subject-matter expertise.

C. Changing Technology

Another influence on the tremendous ongoing changes in higher education that is closely related to the rise of the internet and the information age is the rapid global advancement in technology. On the one hand, work place demands for greater specialization, higher mobility, and ongoing skill enhancement further emphasize the need for continuing education and life-long learning. On the other hand, globalization in the workforce creates the need for cross-cultural competencies and experiences as a crucial element of the professional skill-set in the 21st century. While it once may have been sufficient to formally engage in training and education at the beginning of most professional careers, an increasingly technology-driven work environment that continuously renews and reinvents both itself and its demands on employees necessitates an ongoing, career-long engagement with a broad range of information and communication technologies (ICTs) and their uses as cognitive tools [14].

Concurrently, these same ICTs afford higher education providers increasing global reach to fulfill those educational demands, and the adoption of online distributed course models and degree program offerings increasingly have become the universities' main answer to fulfill those needs. It is predicted that in the two decades between 2004 and 2025, the worldwide body of international learners (i.e., those studying at universities outside of their home countries) will have quadrupled, and already in 2010, online course enrollment growth rates in higher education in the U.S. by far outpaced those of the total number of student enrollments [17]–[19]. While this adoption of e-learning approaches in higher education initially may have raised questions about merit, the main concern today is not anymore whether online instruction is effective but how to maximize its success, with student engagement, interactivity, and communication emerging as the crucial elements.

D. Changing Student Demographics

While online academic offerings may be the answer to the changing global workforce needs, thanks to their afforded on-demand access from anywhere at any time, they are especially attractive to non-traditional and international learners previously unable to attend conventional university programs full time [20]. Therefore, the ongoing changes in the higher education landscape have also led to vastly diversified student populations at universities, especially in online classes, with individual and cultural student backgrounds representing a wide spectrum of competencies, attitudes, beliefs towards the use of technology, subject matter content and the learning process, communication, cooperation, and collaboration aspects of work [1], [3]. In general, these students may be older and are often already full-time employed in their professional careers. Thus, they are financially more independent but also have to balance more different responsibilities in their lives besides school, such as family, job and career, and other commitments within their communities. Therefore, they may be only part-time enrolled in their academic endeavor and may have delayed or interrupted their higher education progress because of work, family, or even military careers. In short, these non-traditional learners may reflect the most salient characteristics of adult learners as outlined in adult learning theory [21].

E. Changing Philosophies

These changing student demographics in higher education, especially within the e-learning environments, obviously also require different approaches to instruction. ALT [21]–[23] and transformative learning [24] may provide a framework to engage students with different dispositions towards learning and actively involve them in the process, while flexibility and adaptability of instructional design and delivery may help to account for cultural differences among learners [25], [26]. However, ultimately, each individual should probably be considered a unique learner, leading to the idea of individualized, learner-centric education as the new standard to achieve. The acknowledgement that progress and process, not just completion and outcome, should be the main focus in an educational thinking that has shifted from teacher-centered, content-based transmittal of knowledge towards a learner-centered emphasis on development [27]–[30] is not just applicable in the online learning environment [23], [31], but it is probably most noticeable here. In a sense, in traditional settings, we may just have gotten away with dictating what students need to know because they were young, inexperienced, and easily amenable to our way of thinking, and we could "force" them to engage with whatever we deem important. However, in the online environment in which there is a multitude of choices and stimuli, all simultaneously competing for attention, students' internalization of the learning process [32]–[34] becomes paramount for success. These intrinsic types of motivation can only come from activities that are relevant to the learners, align with their personal interests, and provide personal meaning [34], [35] because they depend

on the learner's perceived competence, autonomy, and relatedness [35]. Providing students with individualized choices in and responsibilities for their learning processes is consistent with the idea of students as active agents "...who influence what happens to them" [36], and the available web applications and ICT tools should be leveraged to accomplish this goal. Similarly dependent on student motivation and involvement is the increasing need for self-engaged learning [23]. On the one hand, the before-mentioned requirements for life-long learning in the 21st century and continuing holistic development [37] are dependent on the students' abilities to self-motivate, self-direct, self-reflect, self-regulate, and self-correct [23], but particularly for online higher education, self-regulation seems especially pertinent "...because successful learning online depends upon the student's discipline, self-direction, and ability to remain motivated" [38]. Self-regulation, which represents learners' ability to plan and control their learning activities while judging and monitoring their progress and reflecting on the outcomes [27], [39], [40], provides the basis for the before-mentioned constructivist creation of knowledge that can lead to transformative online learning experiences and should be promoted in the design and delivery of online course and program offerings.

F. Changing Role of Assessment

In this context, the changing learning environment also dictates changes to our approaches to student assessments. While the outcome-oriented, content-driven view of education as knowledge transmission of the past has favored the backward design of learning activities with emphasis on measurable after-the-fact tests, this over-reliance on criterion-referenced, summative forms of assessment may not be appropriate anymore in individualized, learner-centric education that aims at life-long learning and holistic development across multiple learning domains [7]. The paradigm that all learning can be predicted and planned and that the desired amount of knowledge to be gained by a learning activity is a fixed entity, as emphasized by pre-defined learning outcomes, seems to be a relic of the prescriptive mode of teaching and should be critically re-examined for its applicability to 21st century learning. Thus, more important for the engagement of students in the online learning environment, the development of their self-regulation skills, and the applicability to meaningful and relevant project-based learning activities that encourage open-ended discourse and life-long personal development seems to be the use of formative forms of assessment and multi-aspect evaluation strategies [7], [30], [41]–[44]. Such process-oriented measures can provide "assessment for" and "assessment as learning" rather than just "assessment of learning" [45], giving students opportunities to reflect on their progress (i.e., reflection for, in, and on action [46], [47]) while also informing the teaching processes and allowing to tailor course design and instruction to individual needs [25], [26], [30], [48]. Thereby, technology can provide new means and novel tools such as stealth assessments, embedded progress

control, or online survey tools [28], [30], and faculty need to develop the skills necessary to employ and interpret those.

III. ADULT LEARNING THEORY

In general, when we talk about incorporating adult learning considerations into online education, we are basically concerned with shifting our teaching philosophy from a model of knowledge transmission to a model of constructivist (shared) knowledge (co-)creation [11]–[14], [21]. This shift should not be seen as a binary choice between one or the other extreme, but as instructional choices made on a continuum of possibilities that can and should be flexibly adapted to the specific setting and the individual learner needs [21]. Adult learning theory provides us with a framework of aspects and considerations for our selection processes but remains open and inclusive enough to accommodate a variety of different learning philosophies and theories, ranging from the behavioral to the constructivist, organizational, social, and critical, which includes perspectives such as Andragogy, Pedandogy, Transformative Learning, Experiential Learning, Self-Regulated Learning, Social-Cognitive Learning, Social-Constructivist Learning, Problem- and Inquiry-Based Learning and many others [21]. Our goal is to identify the particular aspects of the theory that can guide our course design and delivery in the online environment.

First formalized in 1980 by Knowles, ALT is built on the assumption that a mature student differs from a child or teenage learner in six main areas: [21], [22], [49]

- **Self-Concept.** Adult learners see themselves as responsible for their own behavior and decisions in life. Thus, they seek more autonomy and self-directedness in their learning.
- **Learner Experience.** Adult learners have more and diverse experiences to draw from in their learning. This difference in the quality and quantity of experiences can be both a resource for and a barrier to adult learning
- **Readiness to Learn.** In contrast to child or young learners who are more or less sent to school in preparation/anticipation of a productive life ahead of them, adult learners become ready to learn by perceived needs in their current personal and professional setting. Thus they are aware of and connected to specific and relevant problems, projects, and tasks in their life that their learning aims to address. Progression through adult developmental stages such as marriage, child birth, or career change becomes a driver for this readiness, and learning should be timed accordingly.
- **Orientation to Learning.** In contrast to young learners delayed application of learned knowledge and content, adult learners seek immediate relevance of their learning, especially to their other roles in life. They want to be actively involved in the learning process and seek opportunities to directly apply their gained experiences in a practical context. Thus, young learners are more subject-oriented learners, while adult learners may benefit from task- and problem-centered learning.

- **Motivation for Learning.** Since, as previously highlighted, adult learners are more independent and self-engaged in their learning and possess a greater amount of experiences to relate to and draw from, they also seem to respond better to internal types of incentives. While both children and adults may be motivated by external pressures such as grades, promotions, and wage increases, adults seem to be less responsive to those while internal motivators, and potential de-motivators (e.g., negative self-concept) can become strong sources for behavioral regulation in learning.
- **Focus. The need to know.** More than children, adult learners need to know why they require certain knowledge.

Thus, the underlying presumptions are that younger learners such as children seem less application oriented and therefore, require more structured relationships between subject matters. Their focus is therefore more on the learning of content than on the solving of concrete problems, and new knowledge is interrelated and structured according to content topic rather than by task-oriented applicability. In contrast, adult learners are focused on problems relevant to their professional and personal setting, connecting most of their practical need to learn with their intended application of the learned knowledge in their life. Thus, while children are still very dependent on an external instructional structure that guides their studies, adult students seem more selective and self-directed in their learning. However, it should also have become clear that this level of dependency should be seen more on a continuum than in absolute terms, potentially differing even within the same learner depending on the specifics of each learning situation [21]. Therefore, a developmental perspective should be adopted for our continuing discussion here.

IV. ADULT LEARNING THEORY FOR ONLINE EDUCATION

Online learning environments seem to provide the unique opportunity to account for many of the previously discussed differences in learners, whether they are maturity- and development-related or individual-based. However, designers and facilitators have to be aware of these potential differences and have to adopt flexible and adaptable approaches that allow for more individualized, learner-centric facilitation of learning. No longer should we consider students to be a homogeneous group, all starting at the same knowledge base and working towards a common goal. Therefore, the focus should not be on figuring the most effective way to transmit knowledge (and later test it) in a teacher-centered, content-based paradigm but to develop students' competencies in independently gaining task-relevant knowledge that is applicable for realistic problem-solving [27]–[30].

To effectively teach, or more precisely to facilitate effective learning [21], it is vitally important for educators to a) know their audiences and adapt their methodologies and practices to students' needs; b) know their available tools and technologies, with all their advantages and disadvantages to select the best possible approaches; c) assess the learning objectives, the content of their subject area, and the circumstances under

which the learning is desired and under which the learned knowledge, skills, and attitudes are later applied [21]; d) know their strength and weaknesses as faculty and human beings to achieve the ultimate instructional goal: Facilitating student learning by providing learning experiences through the selection of activities, tools, and methodologies that are properly aligned with the content, the students, the teacher, the available technology, and the context.

Some of the specific suggestions that are a direct consequence of the application of ALT in online activity design and delivery and that will be further examined in the next phase of this research include:

- **The need for more formative assessments.** An increase in the use of formative types of assessments (including their automation) may allow real-time tracking of student progress and the flexible adaptation of didactic approaches, while a reduction in the reliance on summative forms may free faculty capacities to allow more individualized student engagement.
- **The need to incorporate more problem-oriented and inquiry-based learning.** A greater reliance on real-world problem and scenario -based approaches that are meaningful and relevant to the students, coupled with a reduction in the reliance on textbook and lecture -based instructional methods may allow adult learners to better put gained knowledge into appropriate contexts and can provide more direct applicability of the learned content.
- **The need for greater inclusion of students into decision processes.** By increasing students responsibility and autonomy, self-directedness and -engagement can be promoted, and students can become better agents of their own learning.
- **The need for more collaboration.** Shared meaning-making and communal reflection seem to support social-constructivist knowledge creation, while communication and coordination needs in teamwork may help to build valuable 21st-century workforce skills, especially in a globally distributed online environment.
- **The need for greater use of ICTs as cognitive tools.** For the larger goal to learn to properly manage and apply knowledge and information rather than just accumulating it (for a test), it seems paramount that students practice the extension of cognition via technology.
- **The need for more guidance and mentorship.** For more individualized and self-regulated learning to be successful, it seems crucial that faculty is available as guide and mentor. However, that also seems to require more administrative commitment to allow faculty to assume these roles.

V. CONCLUSION

As with the other aspects of the Andragogical Model, the online environment may also hold some crucial opportunities to enhance intrinsic levels of motivation in adult learners. For example, the flexibility to study at a time and place convenient for them has already afforded many adult professionals a

chance to self-actualize through learning when they otherwise would have experienced logistic barriers. Nevertheless, inflexible course and curricula designs, and over-emphasis on (mostly summative) assessments, as well as the dangers of isolation and dissociation in online learning environment may also present enormous challenges to effective facilitation of adult distant learning. Therefore, adaptable course and activity designs and their flexible, individualized application during delivery must be implemented. Given the diverse body of learners in adult online educational settings, no single size will fit all, or even any, of the diverse circumstances, especially not with regard to learner motivation. So, online facilitators of adult learning, first and foremost, need to account for individual learner needs.

REFERENCES

- [1] G. M. Johnson, "On-campus and fully-online university students: Comparing demographics, digital technology use and learning characteristics," *Journal of University Teaching & Learning Practice*, vol. 12, no. 1, pp. 1–13, 2015. [Online]. Available: <http://ro.uow.edu.au/jutlp/vol12/iss1/4>
- [2] H. Ilgaz and Y. Gulbahar, "Why do learners choose online learning: The learners' voices." *International Association for Development of the Information Society*, p. 20, 2017. [Online]. Available: <https://files.eric.ed.gov/fulltext/ED579379.pdf>
- [3] S. Vanslambrouck, C. Zhu, K. Lombaerts, B. Philipsen, and J. Tondeur, "Students' motivation and subjective task value of participating in online and blended learning environments." *The Internet and Higher Education*, vol. 36, pp. 33 – 40, 2018.
- [4] P. Mahabeer and T. Pirtheepal, "Assessment, plagiarism and its effect on academic integrity: Experiences of academics at a university in south africa," *South African Journal of Science*, vol. 115, no. 11/12, pp. 32–39, 2019.
- [5] W. Barber, S. King, and S. Buchanan, "Problem based learning and authentic assessment in digital pedagogy: Embracing the role of collaborative communities." *Electronic Journal of e-Learning*, vol. 13, no. 2, pp. 59–67, 2015.
- [6] U. Kakiroglu, "Enriching project-based learning environments with virtual manipulatives: A comparative study," *Eurasian Journal of Educational Research*, vol. 55, pp. 201–222, 2014.
- [7] K. Gündoğdu, "An action research on employing constructivist multi-assessment strategy in teacher education," *International Journal of Progressive Education*, vol. 11, no. 3, pp. 50–63, 2015.
- [8] H.-Y. Chang, C.-Y. Wang, M.-H. Lee, H.-K. Wu, J.-C. Liang, S. W.-Y. Lee, G.-L. Chiou, H.-C. Lo, J.-W. Lin, C.-Y. Hsu *et al.*, "A review of features of technology-supported learning environments based on participants' perceptions," *Computers in Human Behavior*, vol. 53, pp. 223–237, 2015.
- [9] J. Moreillon, "Increasing interactivity in the online learning environment: Using digital tools to support students in socially constructed meaning-making," *TechTrends*, vol. 59, no. 3, pp. 41–47, 2015.
- [10] J. Scullion, D. Livingstone, and M. Stansfield, "Collaboration through simulation: Pilot implementation of an online 3d environment," *Simulation & Gaming*, vol. 45, no. 3, pp. 394–409, 2014.
- [11] D. Laurillard, "The pedagogical challenges to collaborative technologies," *International Journal of Computer-Supported Collaborative Learning*, vol. 4, no. 1, pp. 5–20, 2009.
- [12] E. Arenas, "Affordances of learning technologies in higher education multicultural environments." *Electronic Journal of E-Learning*, vol. 13, no. 4, pp. 217–227, 2015.
- [13] A. Konak, T. K. Clark, and M. Nasereddin, "Using kolb's experiential learning cycle to improve student learning in virtual computer laboratories," *Computers & Education*, vol. 72, pp. 11–22, 2014.
- [14] S.-K. Wang, H.-Y. Hsu, T. C. Reeves, and D. C. Coster, "Professional development to enhance teachers' practices in using information and communication technologies (ICTs) as cognitive tools: Lessons learned from a design-based research study," *Computers & Education*, vol. 79, pp. 101–115, 2014.
- [15] R. Goodwin, "An examination of conflicting theoretical perspectives in learning & teaching," *Arab World English Journal (AWEJ) Vol.*, vol. 6, 2015.
- [16] O. Lourenço, "Piaget and vygotsky: Many resemblances, and a crucial difference," *New ideas in psychology*, vol. 30, no. 3, pp. 281–295, 2012.
- [17] G. Sadykova, "Mediating knowledge through peer-to-peer interaction in a multicultural online learning environment: A case study of international students in the us." *International Review of Research in Open and Distance Learning*, vol. 15, no. 3, pp. 24 – 49, 2014.
- [18] I. E. Allen and J. Seaman, *Changing course: Ten years of tracking online education in the United States*. ERIC, 2013.
- [19] ———, "Digital compass learning: Distance education enrollment report 2017," *Babson survey research group*, 2017.
- [20] V. Chang, "Review and discussion: E-learning for academia and industry," *International Journal of Information Management*, vol. 36, no. 3, pp. 476–485, 2016.
- [21] M. S. Knowles, E. Holton, and R. A. Swanson, *The adult learner: the definitive classic in adult education and human resource development*, 8th ed. Abingdon: Routledge, 2015.
- [22] R. Halpern and C. Tucker, "Leveraging adult learning theory with online tutorials," *Reference Services Review*, vol. 43, no. 1, 2014.
- [23] S. Samaroo, E. Cooper, and T. Green, "Pedagogogy: A way forward to self-engaged learning," *New Horizons in Adult Education and Human Resource Development*, vol. 25, no. 3, pp. 76–90, 2013.
- [24] P. Cranton, E. W. Taylor *et al.*, *Transformative learning theory: Seeking a more unified theory*. San Francisco, CA: Jossey-Bass, 2012, pp. 3–20.
- [25] X. Liu, S. Liu, S. Lee, and R. J. Magiuka, "Cultural differences in online learning: International student perceptions." *Educational Technology & Society*, vol. 13, no. 3, pp. 177–188, 2010.
- [26] P. Parrish and J. Linder-VanBerschot, "Cultural dimensions of learning: Addressing the challenges of multicultural instruction," *The International Review of Research in Open and Distributed Learning*, vol. 11, no. 2, pp. 1–19, 2010.
- [27] J. Mao and K. Peck, "Assessment strategies, self-regulated learning skills, and perceptions of assessment in online learning." *Quarterly Review of Distance Education*, vol. 14, no. 2, 2013.
- [28] M. C. Murray, J. Pérez, D. Geist, and A. Hedrick, "Student interaction with online course content: Build it and they might come," *Journal of Information Technology Education: Research*, vol. 11, no. 1, pp. 125–140, 2012.
- [29] C. Zhou and A. Purushothaman, "The need to foster creativity and digital inclusion among women users in developing context—addressing second order digital divide in online skills," *International Journal of Emerging Technologies in Learning*, vol. 10, no. 3, 2015.
- [30] J. M. Spector, D. Ifenthaler, D. Sampson, J. L. Yang, E. Mukama, A. Warusavitarana, K. L. Dona, K. Eichhorn, A. Fluck, R. Huang *et al.*, "Technology enhanced formative assessment for 21st century learning," *Journal of Educational Technology & Society*, vol. 19, no. 3, pp. 58–71, 2016.
- [31] R. Deakin Crick and C. Goldspink, "Learner dispositions, self-theories and student engagement," *British Journal of Educational Studies*, vol. 62, no. 1, pp. 19–35, 2014.
- [32] M. Gagné and E. L. Deci, "Self-determination theory and work motivation," *Journal of Organizational Behavior*, vol. 26, no. 4, pp. 331–362, 2005.
- [33] R. M. Ryan and E. L. Deci, "Intrinsic and extrinsic motivations: Classic definitions and new directions," *Contemporary Educational Psychology*, vol. 25, no. 1, pp. 54 – 67, 2000.
- [34] ———, "Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being." *American psychologist*, vol. 55, no. 1, p. 68, 2000.
- [35] B. Meissner and F. X. Bogner, "Science teaching based on cognitive load theory: Engaged students, but cognitive deficiencies." *Studies in Educational Evaluation*, vol. 38, no. 3-4, pp. 127–134, 2012.
- [36] R. Carver, R. King, W. Hannum, and B. Fowler, "Toward a model of experiential e-learning," *MERLOT Journal of Online Learning and Teaching*, vol. 3, no. 3, pp. 247–256, 2007.
- [37] S. A. Hillen and M. Landis, "Two perspectives on e-learning design: A synopsis of a us and a european analysis," *The International Review of Research in Open and Distributed Learning*, vol. 15, no. 4, 2014.
- [38] K. A. Meyer and V. S. Murrell, "A national study of theories and their importance for faculty development for online teaching," *Online Journal of Distance Learning Administration*, vol. 17, no. 2, pp. 1–15, 2014.

- [39] J. Broadbent and W. L. Poon, "Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review," *The Internet and Higher Education*, vol. 27, pp. 1–13, 2015.
- [40] V. Kovanović, D. Gašević, S. Joksimović, M. Hatala, and O. Adeso, "Analytics of communities of inquiry: Effects of learning technology use on cognitive presence in asynchronous online discussions," *The Internet and Higher Education*, vol. 27, pp. 74–89, 2015.
- [41] Z. G. Baleni, "Online formative assessment in higher education: Its pros and cons," *Electronic Journal of e-Learning*, vol. 13, no. 4, pp. 228–236, 2015.
- [42] G. D. Kuh, S. O. Ikenberry, N. A. Jankowski, T. R. Cain, P. T. Ewell, P. Hutchings, and J. Kinzie, "Beyond compliance: Making assessment matter," *Change: The Magazine of Higher Learning*, vol. 47, no. 5, pp. 8–17, 2015.
- [43] A. A. Whittaker, "Effects of team-based learning on self-regulated online learning," *International journal of nursing education scholarship*, vol. 12, no. 1, pp. 45–54, 2015.
- [44] M. Webb and D. Gibson, "Technology enhanced assessment in complex collaborative settings," *Education and Information Technologies*, vol. 20, no. 4, pp. 675–695, 2015.
- [45] L. M. Earl, *Assessment as learning*. Corwin Press, 2006.
- [46] R. Bubnys and V. Žydzūnaitė, "Reflective learning models in the context of higher education: Concept analysis," *Problems of Education in the 21st Century*, vol. 20, 2010.
- [47] A. Le Cornu, "Building on jarvis: Towards a holistic model of the processes of experiential learning," *Studies in the Education of Adults*, vol. 37, no. 2, pp. 166–181, 2005.
- [48] M. Wang, "Designing online courses that effectively engage learners from diverse cultural backgrounds," *British Journal of Educational Technology*, vol. 38, no. 2, pp. 294–311, 2007.
- [49] D. C. Taylor and H. Hamdy, "Adult learning theories: Implications for learning and teaching in medical education: AMEE guide no. 83," *Medical teacher*, vol. 35, no. 11, pp. e1561–e1572, 2013.