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iDEA-SLO:intelligent Distributed Education Advocated as Sustainable Learning Outlets

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Abstract

Intelligent distributed education advocacy for sustainable learning outlets (iDEA-SLO) has emerged from cloud-based intelligent service by combining educational innovations to satisfy modern learners' needs with sustainable learning outlets that combine traditional classroom and comprehensive online courseware (CoC). One such innovation introduces a ground-breaking concept to embrace sustainable learning through structure, spontaneity, smoothness and synthesis. These bring great intelligence or skill into learning, making it enjoyable while also eliminating boredom and redundancy from classes. The sustainability of learning mirrors traditional student learning outcomes (SLO) that aim for *learning outcomes*, and *instructional outlets* through universal interactivity for student-centered engagement. This paper presents

iDEA-SLO for sustainable learning that novelly morphs into *structural* operation, *spontaneous* option, *smooth* refinement, and *synthetic* codification. The blended iDEA-SLO advances hybrid learning across traditional learning (in the classroom) and sustainable life-long learning in an eclectic & elastic approach. Central to sustainable learning outlets, artificial intelligence & machine learning (AIM) play a key role in S^4LO: structural operation, spontaneous option, smooth refinement, and synthetic codification through a lean-tiered outlet. As a result, the intelligent distributed education advocacy (iDEA) enables S^4LO to be blended comprehensively with holistic (synthetic) courseware, harmonious (self-paced & instructional) activities, hands-on (structural) coursework to harness educational equity & excellence through an AI-empowered "digital twin" that encourages divergences of learning need. As a result, iDEA-SLO works in tandem with cloud extraction, digital transformation, and archival loading to provide an improved series of cloud intelligent services available at a learner's fingertips.

Keywords: AI-harnessed "digital twin" for educational equity, SLiM-CD, Sustainable Learning information Management & Content Delivery

1. Introduction

Since the pandemic, intelligent distributed education has promoted sustainable learning outlets (iDEA-SLO) that emerged from Hybrid Learning via web-based intelligent service engaging with Cloud Intelligent Outlet (wiseCIO). It combines educational innovations to satisfy modern learners' needs through sustainable learning. Intelligent distributed education advocacy actually orchestrates advanced distributed learning (ADL) for sustainable learning. The ability to dedicate Collective Intelligent Courseware (CIC) via universal interactivity (UI) plays a key role in course management in cloud / digital archival repository express (CARE/DARE) and content delivery through web-content boxes (WCBs). With the potential universal interactivity, Sustainable Learning is considered as a collaborative Outlet (SLO) to serve learners with comprehensive instructional modules, which would have a great impact on higher education.

Cloud-based intelligent service propels Blended Learning (BL), or "hybrid learning (HL)," whose aim is to blend both a traditional classroom setting and an online learning environment as a whole. Presently, there is a recognized trend in schools and universities that has shifted to

blended learning in addition to responding to the changing ways that today's generation of students normally receives information. Blended Learning has shifted the traditional classroom into online learning, gaining traction well before COVID-19 because of advanced technology that makes online materials archivable (easy to manage), accessible (easy to visit), available (anywhere via a variety of electronic devices). Since 2000 the online education industry [1] has grown 900%—and that number is expected to triple by 2025. As more institutions embrace the combination of in-person and online learning, it's likely that blended learning is here to stay. If one is a teacher or student, it's important to be familiar with this model because he is likely to come in contact with it in the near future.

Here is one of many testimonies that reflect Blended Learning [1]:

"A glimpse into my current classroom, on and off campus, puts a light on a place where learning exists between multiple dynamics, devices, and synergies. Hybrid learning is embraced and becomes a place of discovery during every class. I must constantly keep my touch on the pulse of the mindset of the students I am teaching, who have lived through the COVID-19 pandemic. … As a professor, it challenges me to continue to learn and rise to the digital challenge. I use technology during class in ways that challenge my students to find information beyond the lecture of the topic we may be discussing or learning. The capture, digestion, and regurgitation of information retrieved online can be endless and exciting to the student. Hybrid learning leaves room for the students to become the initiators of the conversation's direction, thereby giving them a sense of ownership of moving deeper into the subject matter."

Blended Learning: Like a two sided coin with benefit and challenge

It is blended learning that encourages instructors to use additional educational tools for increased engagement. By utilizing the online element, instructors have more learning tools with which to work such as gamification, video, and interactive simulations [2], allowing for new ways to engage and motivate students. For example, the interactive simulations (PhET) help students visualize lots of physical phenomena by hands-on virtual and experimental labs, so that students, while operating, are greatly engaged with game-like simulating labs. Hybrid modeled courses have proven to be more engaging for students of all ages—from elementary school to higher education which turns learning from redundant lecturing to wonderful operations of game-like hands-on experiments. A study by the Center for Digital Education [3]

[1] We have collected testimonies from professor of different subjects, and which indicates the charming of blended learning

found 73% of educators who utilize this model saw an increase in student engagement.

Online orchestrated support for individualized instruction allows instructors to mix and match educational tools and courseware according to the needs of their classroom. They can design lessons so that students can learn independently online and then follow up with face-to-face discussions or at virtual meetings. With personalized courseware, blended learning is considered student-centered by design. By incorporating the online learning element, students have more flexibility with regard to when, how, and where they receive instruction. Students can access learning materials at their own pace and take time to reinforce what they learned in the classroom.

Online evaluations can be made available anytime; anywhere with internet access. Instant evaluations are very helpful for teachers to more accurately assess and track a student's mastery of the material. For example, when students take a quiz online, the teacher is able to get immediate results and the student is able to get immediate feedback. In a recent study, 79% of students surveyed said they felt more autonomous in a blended learning environment due to the fact that BL/HL requires a learner to be more active in education and utilize goal setting and time management strategies to move through their coursework.

However, there are a few challenges to hybrid learning. First, blended learning may suffer from a lack of IT training, and / or students' accessibility to computers and networking. Blended learning may only be effective when it is supported by the right technology, equipment, and software. Because of the lack of IT training, teachers (especially those who are not tech-savvy) need the right training and support for online instruction, and not every school is able to facilitate this. Unfortunately, not every student has access to a computer and the internet. Second, adjusting to blended learning can be a challenge for teachers who have students requiring more supervision or who have less motivation in an online environment compared to a face-to-face experience. When the internet doesn't work, or when programs and software are down, students are unable to access their courses. This can be frustrating for many students, although these bugs are often fixed quickly, and students are able to continue with their work.

Artificial intelligence via algorithmic machine learning is central to overcoming the above mentioned challenges, which has been renovate & resolved to somewhat extent from our previous effort dedicated to higher education, such as wiseCIO [4], iDEAL-CIO [5],DATA [6], CARE [7].

iLEARN: Contributions to innovate with LEARN

iDEA-SLO or sustainable learning outlet via instruction management & content delivery, is productive through iLEARN as follows:

Lean tiered sustainable learning outlet (SLO) aims for universal interactivity that simplifies human-computer interaction at user's fingertips so that anyone may become an expert in courseware for hybrid learners through readily available operations. The intelligent outlet accommodates diverse needs from students for the divergent instruction is customized to engage the learner.

Engaging for educational excellence and equity with individualized materials available at the user's fingertips propagates student-centered learning experience, and as a plus, the Magic GIFT [8] places the student in the driver's seat to ensure a self-paced approach for his or her studies. The concept behind the Magic GIFT is that it represents a dynamic approach to looking up by re-grouping learning segments that reflect the user's interests and dedicating without boredom because it is specifically user generated.

AIM (artificial intelligence & machine learning) promotes cloud-orchestrated intelligent service in support of the above mentioned features, such as lean tiered outlet, and engaging for educational equity & excellence. The blended pedagogy represents convergent intelligence that can be modified through the lean-tier outlet to individualize divergent instruction. With AIM, Lean-tiered outlet makes more sense with universal interactivity and students centered experiences. Furthermore, an advanced Magic GIFT could be a "digital twin" to the specific learner via AI-empowered divergent instruction [9]

Revenue (borrowed meaning) promotes "gains" that a learner can receive regularly and incrementally as outcomes through the SLO, which maintains balance between convergent intelligence (pedagogical approach) and divergent instruction (individualized learning experience).

Novel solutions with an iDEA-Knowledgebase (iDEA-Kb) are advocated for intelligent distributed education through customized learning in a self-paced approach with individualized materials offered at the users' pace and fingertips.. Although there is No Silver Bullet, novel AIM solutions are offered to excel STEAM even further.

Organization of the paper

Section 2 discusses iLEARN by deriving SLO (conceptual innovation) into S4LO (concrete

instructions) through structural operations, spontaneous optionals, smoothness between “the known” and “the unknown” (like parables help understanding), and synthetic codification for abstracted usage.

Section 3 is an in-depth exploration of how intelligent distributed education advocates sustainable & lifelong learning through STEAM by integrating Arts (to visualize imaginary beauty), Advanced Technology (to simulate interactively), and Artificial Intelligence (to promote content management and delivery).

The conclusion summarizes the discoveries by iDEA-SLO :)

2. SLO: Sustainable Learning Outlets for iLEARN

A three-tiered framework facilitates Intelligent distributed education, consisting of universal interactivity (user tier toward the learner), student-centered engagement (app tier enabled by AIM), and Comprehensive online Courseware (CoC) together with Hands-on Coursework (HoC) in support of sustainable / smart learning, as illustrated in **Figure 1**.

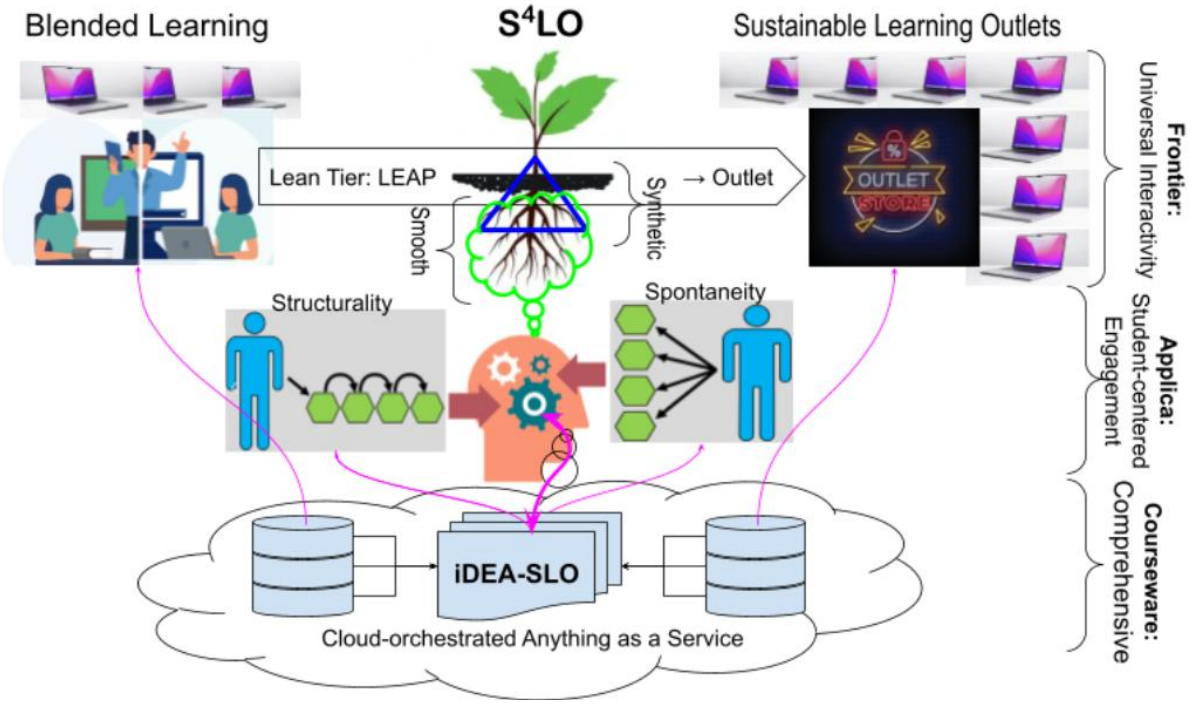


Figure 1. iDEA starts with a three-tiered framework: Frontier-Applica-Courseware

The three-tiered framework accommodates sustainable learning with universal interactivity for human-computer interaction, student-centered engagement with individualized content delivery, and comprehensive online courseware that provides learning content in digital

archives consisting of lecture notes, webinar, and multimedia:

- ***Tier 1. Frontier*** ~ interfaces between the user and the blended learning service is also known as a lean-tiered outlet via universal interactivity toward user-friendliness.

- ***Tier 2. Applica*** ~ models the sustainable learning information management & content delivery (SLiM-CD) for user-centered engagement with customized learning modules / segments applicable and available at user's fingertips. Applica dedicates sustainability to 4 "S" approaches: structure, spontaneity, smoothness, and synthetics, transitioning from convergent intelligent dataset(?), through dataset fine-tuning, in order to customize for the divergent needs [10].

- ***Tier 3. Courseware*** ~ embodies the diverse (anything as a) service derived from convergent / pedagogical intelligence. That is, comprehensive online courseware (CoC) and hands-on coursework (HoC) are "two sides of one coin": convergent intelligence for comprehensive (ubiquitously) education through sophisticated pedagogy, and divergent instruction that makes the student feel (unique).

The conceived sustainable learning outlet (SLO) will extend further discussions into four "S" aspects and each serves for a specific purpose. These aspects are recursively composable without limitation because of transformed analytics that help with ETL via OLAP [11], and convergent intelligence can be finely tuned as a "digital twin" aligning with divergent learning needs [9, 10].

2.1 Structural learning via operational logic

Structural compose-ability represents the ability to build a system from components. Structured learning means learning service residing in iDEA-SLO as courseware, and consisting of modules, and/or segments (sections & sessions) - a segment may represent either a section (one after another) or session (one or the other). Architecturally, structured learning involves functional components and interoperable connections. Functional components are learning segments, and connections promote interaction between components. Systematically, each learning segment has its own functionality and plays a specific role in achieving the overall objectives of the system. The segment is made applicable through inputs, outputs, communication channels, dependencies, or relationships. In particular, structured learning denotes an operational learning process that lays out learning modules logically to

collaborate instructions with students, so a series of learning segments (modules, sections, sessions) can be organized like the Table of Contents, and each of which is also represented as a digital folder that is expandable and contractible.

As a traditional learning style in which all the students are required to show up on time, participate in discussion in person, the sequence of operations fulfills structured learning. And, it also sorts general experience in learning by creating pedagogical pathways to excel STEAM education. Cloud generated structural composition is characterized by an operational logic, so as to establish connections between learning segments "A" and "B" in either sequence or selection, or mixed as well.

It is true that a traditional learning management system (LMS) can do a good job for structural learning operations by structurally organizing learning segments, but there may exist a drawback in the blended learning context. Without assistance by AIM, the standardized segments would bring in some "boredom" - Individual learners would present the same showcase of all individuals. However, this does not reflect individual specific instruction, especially in a self-paced learning environment.

On the contrary, the cloud generated structural composition by iDEA-SLO enables individual learners to share the same operational logic, but to vary engagement of learners with the dynamic context. It alters operational logic either "one after another" in sequence, or "one or the other" in selection. The well-archived courseware in the context of iDEA is a propelled sequence of operational logic between starter and verifier, shown in **Figure 2**.

According to **Figure 2**, the sequence of operational logic is reflected as threaded interactivity between the starter and the verifier, which may be trivial, but is very significant for student engagement into their learning with AIM's help. The student takes initiative as a starter interacting with the verifier as a correspondent to assist with an intelligent agent. The agent is clever to compose courseware (comprehensive instruction), to generate rubrics (the means to evaluate), and to conduct coursework (as assigned for submission). The threaded sequence in between reflects user experience of structural composition to engage with "trial-error" (re-do for correction or revenue as outcomes) through hands-on operations, as anticipated engineering saying goes, "I do. And I understand". OLAP will apply to the retrieval of assignments from the lifelong learning library collectively.

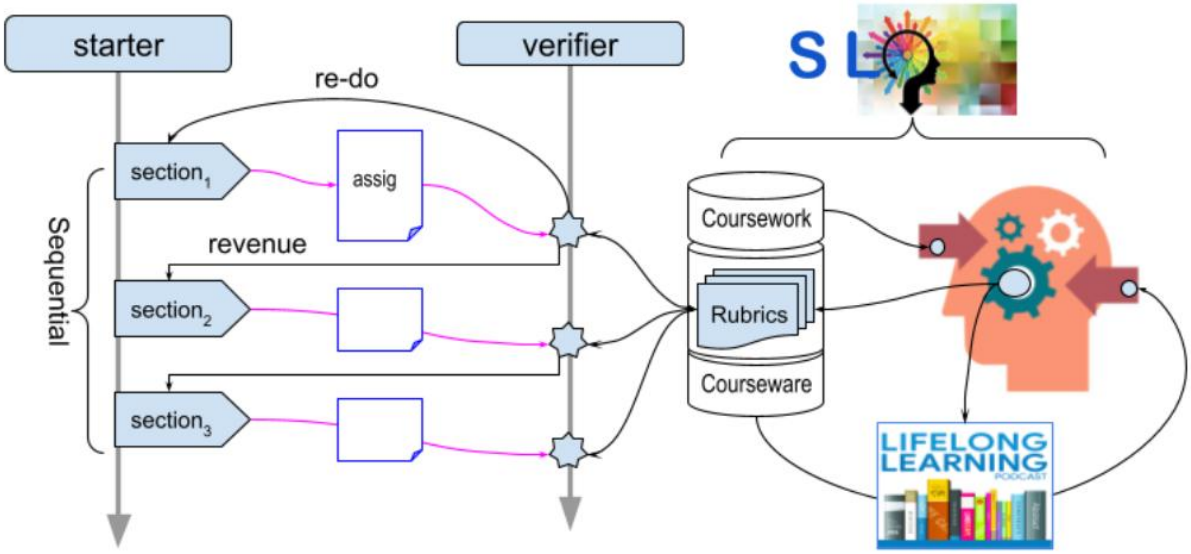


Figure 2. Structurality ~sequence of operational logic: interaction between trial-error & revenue

2.2 Spontaneous options in depth or brief

Spontaneity denotes selective options to alter various topics encouraging differentiated learning, either deep understanding or just sampling in brief. The pandemic lockdown may have helped scholars exercise more of their skills in virtual breakout rooms for optional topics. A breakout hosts a group of people, including a scribe and a moderator with a specific focus on a topic to discuss through brainstorming. It works perfectly, especially with complex situations that are broken down into several aspects on the agenda based on the reality that each person may have a limited capacity and can only deal with one at a time.

Spontaneous options are seemingly unplanned (spontaneous), but attract attention to various topics. Specifically, each group can do a good job with details so that the problem-solving can be considerably in-depth - to illustrate: Consider a thorough study on a topic that will bring out a perfect brief / summary for others to understand. As the Learning Pyramid suggests [12], in terms of learning revenue, teaching others (by preparing a brief presentation) will help the original preparers with comprehension up to 90%. The application of spontaneous learning is like cutting a big “pizza” into slides to feed more people – an uncut pizza is like “biting off more than can be chewed”. Spontaneity introduces variations to engage students with various focuses on multiple aspects.

As shown in **Figure 3**, the selective threads between the starter and verifier embody self-motivated learning. The spontaneity enables individuals to select his interests and expect a higher return in “revenue”. The divergent interests motivate learners into deep learning with expertise in teaching others. Spontaneity is effective in the mutual exchange of each

participant's deep learning for a brief understanding of topics at hand. The assignment (assig.) is selected from a family of similarities for divergent thinking.

Tactically, spontaneous options come out of breakdowns over a variety of aspects, and then provide a flexible approach to encourage learners to select a specific topic. It is spontaneity that enables specific aspects to personalize individuals' needs by prioritizing students' talents and interests in a student-centered environment. Multiple aspects can be blended toward the same direction by incorporating the online learning element for flexible learning in WHW (when, how and where) on receiving instruction. The free options are capable of fostering individuals' interest or talent in the fulfillment of educational equity.

Spontaneous learning also demonstrates a practical strategy that introduces purposeful divergence through breakdowns in parallel, then summarizing for convergence in general. In front of a very complex learning module, spontaneous learning helps to focus on the chosen or preferred topic rather than a superficial approach to more general knowledge of the subject area (伤其十指不如断其一指[2]:).

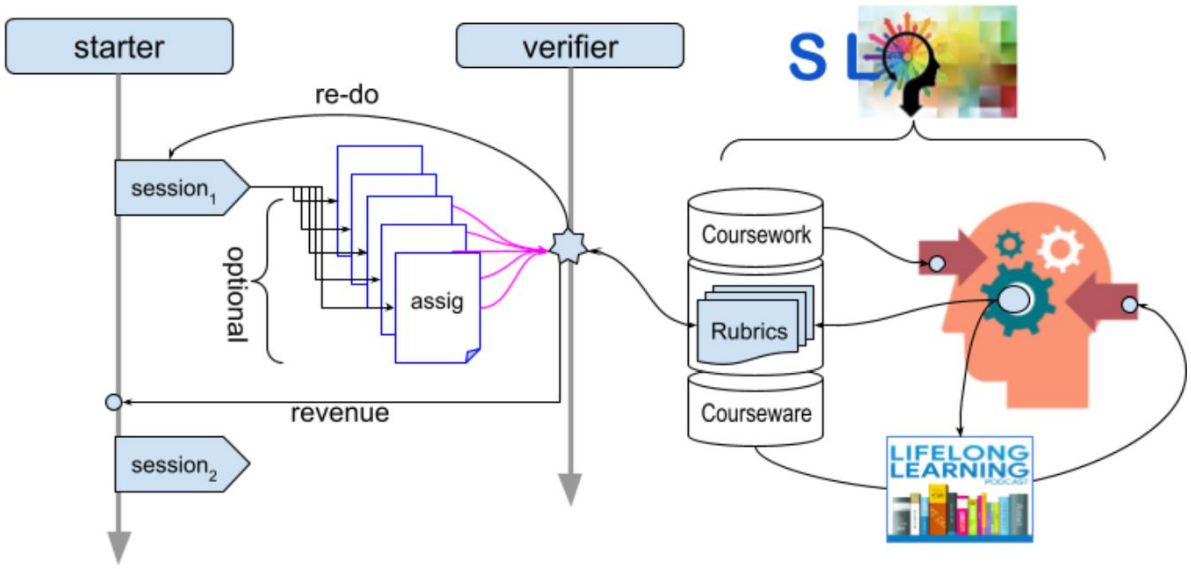


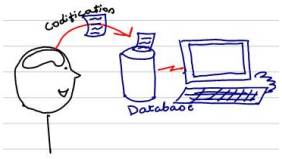
Figure 3. Spontaneity ~ Leverage between deep exploration and brief comprehension

With plentiful content prepared in the courseware, iDEA-SLO makes magic GIFT smarter with each engagement with divergent criteria that may bring out various frontier lean-tiered outlets to meet divergent learning needs. For example, a course can be presented to the Frontier as L.E.A.P. (conceptual learning), and A.L.G.O (hands-on algorithmic processing). By applying spontaneity to dynamically re-grouping, both conceptual learning (LEAP) and

[2] An idiom in Chinese, "It is better to get one job thoroughly done than to get ten jobs roughly done at a time"

algorithmic processing (ALGO) can bring out multiple facets, so that individuals will make choices by digging into the content (... further discussion in case studies).

2.3 Synthetics to codify conceptualized learning



Synthetic codification demonstrates a holistic package of a knowledgeable sequence as a whole, so that students can briefly use it to support further exploration. Synthetic codification is an efficient way to abstract a lengthy and detailed process for immediate use. In learning, the mind works more efficiently alternating between the big or global picture and descending into details. There is a time to explore in detail and a time to take in the view from the top. Synthetic codification helps learners to "zoom in" and "zoom out" in their regard of being codifiable to leverage details/trivial for use as a whole.

Codification is often utilized in computational thinking (pattern recognition and abstraction), computerization (input-process-output), and digital transformation [13] (processed from raw to intelligent), which focuses on functionality without unnecessarily referring to how that job is done. One of the most typical examples of codification is algorithmic processing that is triggered by a functional button. So iDEA-SLO is a great tool to codify a lengthy and knowledgeable sequence into an intelligent service so that a simplified action, such as clicking on the button, will bring out a cluster of information.

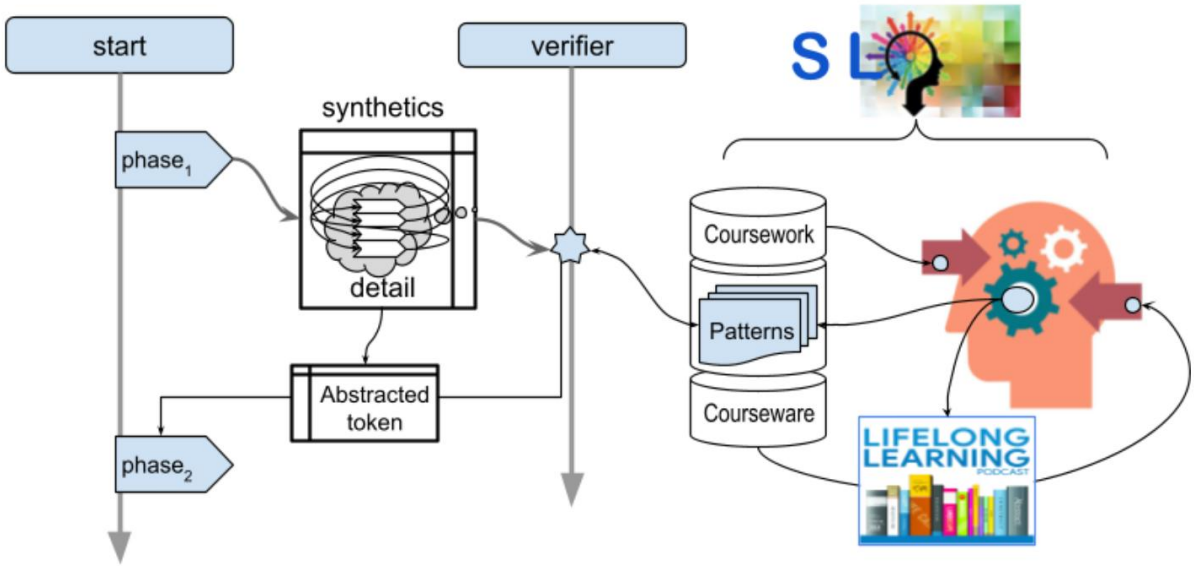


Figure 4. Synthetic Codification: codify the details of sequence into patterns for direct use

Synthetic codification represents computational thinking from decomposed detail (analytics) into abstracted tokens so as to hide information for easy understanding. A good example is the

representation of the CPU (central processing unit) of a computer. A CPU is full of intelligent design with lots of details, but is commonly conceptualized today as an icon. In learning practice, a set of trivial steps must be well-analyzed at phase#1, then they are synthetically codified as an icon for direct use when needed.

Synthetic codification involves simplifying complex systems, ideas, or objects by focusing on essential characteristics while masking or hiding irrelevant details. It plays a critical role in human cognition, enabling us to make sense of the world, develop theories and models, communicate effectively, solve problems, and drive innovation. By simplifying complex systems, ideas, or objects with a focus on essential characteristics, it is significant in Learning and Education so that learners will grasp fundamental concepts and principles before delving into more advanced or specialized topics. By building a foundation of abstract knowledge, learners can better understand and apply complex ideas in various contexts.

2.4 Smooth to sprout knowledge base through learning

Smoothness will of iDEA-SLO allows human strategic solutions to large problem solving in the first place. It applies the “divide and conquer” approach [14] to avoid ‘biting off more than can be chewed”. In computational thinking, the “divide & conquer” reflects decomposition with breakdowns, embodies abstraction for pattern recognition, and algorithmic processing, known as stepwise & refinement, indicating a transitioning from the known to the unknown.

In human traditional wisdom, say “Weighing the Elephant” [15], it also means to smooth out a transferring procedure or transitioning approach that maps the problem to an equivalent yet simplified solution to the original problem. A great example of transferable problem solving is the use of a parable or an ancient story of “the known” to help comprehend “the unknown” [16].

The problem of weighing an elephant without a big enough scale shows the transferable wisdom of Divide-Conquer, illustrated in **Figure 5**. In this traditional story, a smart boy resolved the weighing problem with only a pile of stones, some small scales and a boat. Similarly, a computer may know nothing about images, but pixels of RGB elements that can be processed [17]. So-called digital image processing with GPU, popular in AI for facial recognition, makes unmanned driving over GIS possible over pixels composed of three numbered values: red, green, and blue. It is through pixels in RGBs that an image can be processed for color adjustment, and model recognition, etc.

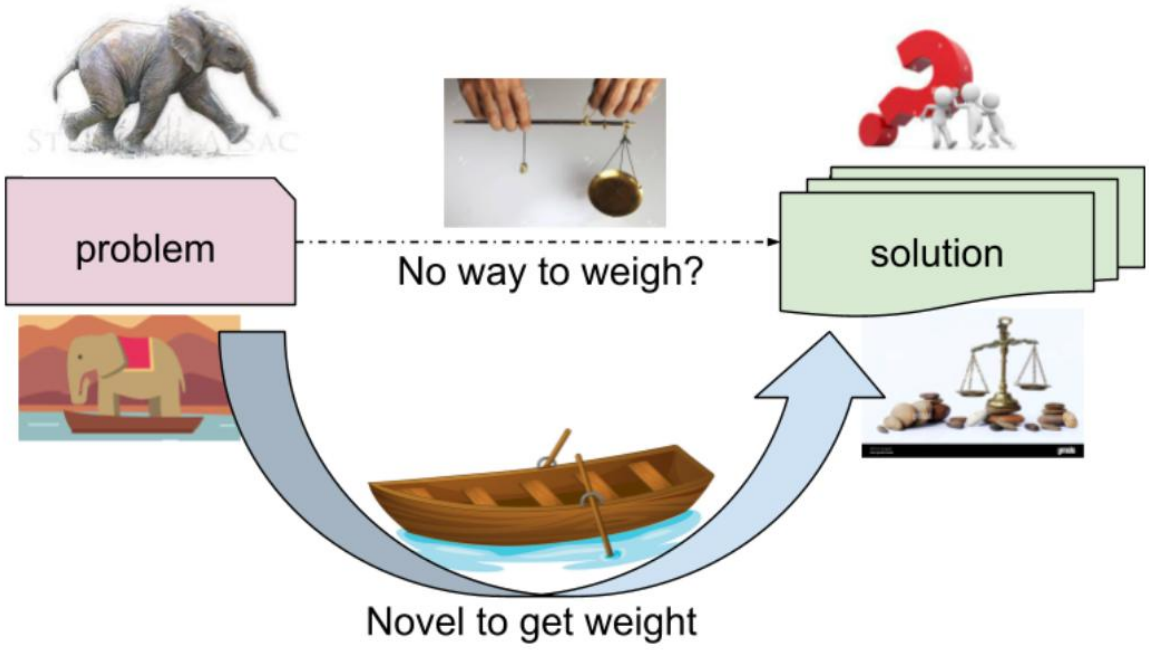


Figure 5. Smoothness ~ piecemeal via spiral iteration on how to weigh stones

Practically, smooth learning via "Divide & Conquer" is more helpful to engage students. It represents a problem-solving strategy that involves breaking down a complex problem into smaller, more manageable parts, solving each part individually, and then combining the solutions to solve the original problem. It is a widely used algorithmic technique in computer science and mathematics.

On the other hand, smooth learning also produces the sprouting of new knowledge that is rooted beneath the known. Since human perception is usually made by thinking, imagining, comparing, then comprehending by duplicating (doing it) - Comparison with and imagination on similarities result in perception of new knowledge.

Take physics as an example in STEAM education, a student may not know much about electron attraction / exclusion between a positive and a negative, but certainly understands male & female. Another good example is found in the saying, "Life is like a box of chocolates". Presumably, everybody is familiar with "the known" candy. However, when seeing a box of chocolates, awareness of candy will be full of expectations, despite having no knowledge of what is actually inside, so a person can't wait to open the box (to discover "the unknown"). Strategically, "the known," like parables in the Bible, students would be more than happy to learn something from the known in their experience that leads to the unknown (new) for the sake of broader understanding.

With regard to parables, if we see the roots beneath as “the known”, the sprouts above the ground as the unknown that are highly anticipated and include beautiful flowers, and sweet fruits, etc. New knowledge has its roots with the fertilized soil that nourishes the plant . This is the idea of Sustainable Learning Outlet.

In iDEA context, smoothness is accomplished or controlled between Hold-up and Fold-out to assist a learner in his self-taught experience. A learning box (content block) is actually a perfect embodiment of Zoom-in (fold-out), and Zoom-out (hold-up). The controllable fold-out is to allow the user to zoom into the box so that he can see more details until he comprehends the beneath, then hold-up is to conceptualize the detailed content to a brief level that helps the learner focus on the main idea, and by ignoring trivial things. Hold-up also enables some knowledgeable things to be directly utilized to support understanding at another level without focusing too much on the trivial things in the moment.

3. iDEA: Intelligent Distributed Education Advocacy

The three-tiered framework accommodates intelligent distributed education advocacy, respectively with: (1) Frontier to dedicate in a friendly way diverse learners to deep learning, (2) Applica to intelligently customize content in USE, and (3) Courseware to comprehensively orchestrate anything as a service. The framework also gradually blends a smooth transitioning between the traditional classroom and comprehensive online courseware (CoC). In other words, an instructor can use the CoC to teach either in a traditional classroom, or in a positive and inspiring online setting. As an asset to engaging students with lifelong learning, a student-centered model turns the instructor into a facilitator, much like a movie director (instead of a diverging actor), and students into active learners much like divergent performers – this kind of interactive and dramatic teaching / learning is predictably able to entertain, educate and engage everybody through deep involvement in the learning environment. It also causes STEM education to excel via educational intelligence that could be either artificial or pedagogical.

3.1 Universal interactivity at one’s fingertips

We can see SLO as a three-in-one iDEA collaboration with human-computer interaction (Frontier), divergent evolution (Applica), and convergent organization (Courseware). Frontier fulfills universal interactivity to befriend individuals with the notion of, "a little bit challenging but a sure thing with rewards”, and customize intelligent service (as a “digital

twin") through Applica. Frontier's universal interactivity conceptually offers folder-like segments that are expandable & contractible without frequent swapping of webpages.

The purpose of education is to spread convergent knowledge, however creativity is largely based on divergent problem-solving. In iDEA-SLO, anything as a service may recall similar operational logic, while also encouraging the exploration of various scenarios for novelty. The taught convergence gives the learner confidence in interacting with familiarity through learning, while divergent and novel problem-solving motivates curiosity through exploration. Universal interactivity (UI) makes sense with operational learning at learners' fingertips without needing to spend time on how to uncover something that may interest the user. In iDEA-SLO, the learning experience is better through universal interactivity (UI). UI must be intuitive, like going with the flow, instructional, like communicating with a mentor. The whole experience is intelligent, like engaging "me" with what is in "my" mind (from a user's perspective). More significantly, UI advances student-centered engagement with self-paced learning.

Learning segments may be defined and expressed as a web-based, interactive, instructional, inspirational composite (Wi3C) to echo universal interactivity. A Wi3C usually appears in the "table of content" and each of which fulfills universal interactivity, characterized as follows:

- ***Expandability*** - as a composite, it can always be enabled to embed content beneath
- ***Contractibility*** - opposite to expandability, it always contracts from the previous expansion
- ***Iconicalibility*** - it integrates icons / buttons to support a separate reference-view in details which show a relationship in between.
- ***Genericity*** - is a great companion to icons and buttons are embedded with a smart player that can play multimedia, such as a traditional webpage, an audio, a video, web-based apps, and so on.

Diagrammatically, parallelograms may be used to easily illustrate a learning segment that may consist of sections and sessions, supporting hierarchical expanding and contracting, as illustrated in Figure 6. A learning segment, appearing in the table of segments, acts like a folder and its body is enclosed in the contentView. The contentView is expandable in either vertical (embedded) or horizontal (cascading) direction. Both reflect user-centered experiences that have readily available content without webpages swapping.

A segment is said to be “expandable”, unlike traditional websites. It enables the “anchor” to embed its contentView beneath the current segment. The iconic nature of the selection will bring out a separate contentView. The “generic” nature also makes the icon smart to bring out multimedia including audio, video, webpages, and so on. Its counterpart is “contractible”, which gets rid of the previously expanded contentView for the sake of staying in brief (reverting back to “Table of Content”).

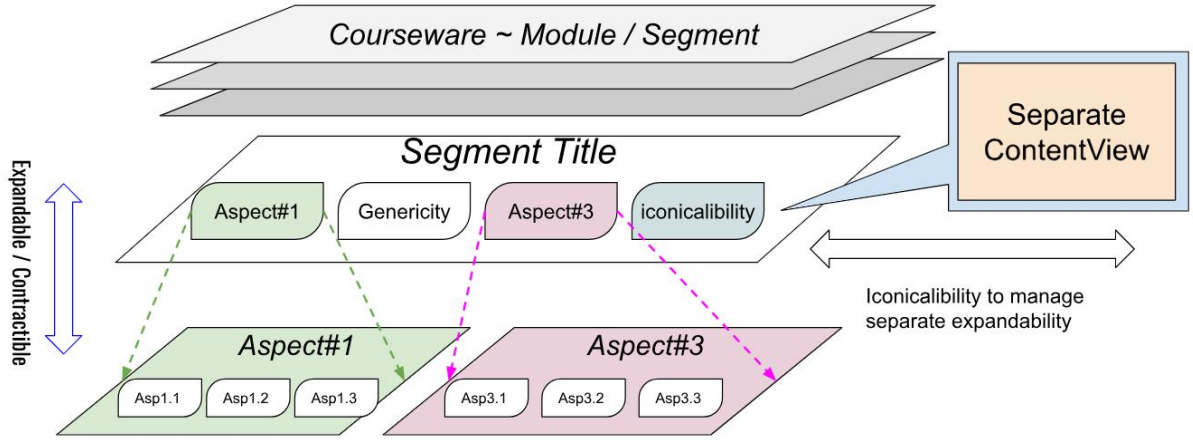
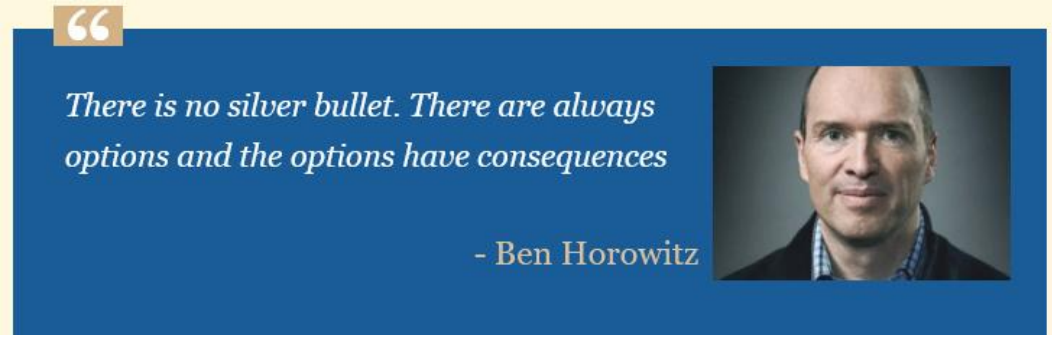


Figure 6. Universal Interactivity (UI): expandable segments for better user experience

Recursively, each parallelogram supports further expansion, which encourages further in depth exploration without messing up the learning segment or leaving to another page. The following case study will further illustrate.

3.2 Universal Interactivity for practical heuristics

Universal interactivity has psychological heuristics in practice, by observing Dr George Miller’s magical number of immediate memory in retrospect, “Magical Number (7 ± 2)” [18] is enough to challenge the capacity of information processing. Psychologically, the Lean-tiered outlet promotes the lean outlet with “simplicity and clarity leading to greater effectiveness”. Heuristics add a kind of AI ingredient to enable software to be smarter without trivial coding required. According to Figure 6, lean outlet promotes an innovative means for content delivery: each segment allocated a certain number of sections or sessions enclosed, the accepted standard is seven, give or take two (7 ± 2) as proposed by George Miller. In this scenario, Simplicity is embraced with a high degree of accessibility, yet is tempered from overabundance of what is readily available. On the contrary, anything organized beyond a certain quantity of items at a time (period) would cause confusion like “biting off more than can be chewed”.



The mind's limit dilemma is best expressed by Ben Horowitz, “There is no silver bullet”, but we can choose to list a bunch of segments in a traditional table of content approach or hierarchically leverage through computational thinking. In the interfacing approach through computational thinking [19], especially with assistance by iDEA-SLO, most courses can start from a “parallelogram” of a few aspects on the top that students can grasp and engage. A refinable segment on the top hierarchical level, such as L.E.A.P. invites a better user experience and encourages or motivates a learner to explore in more depth without overwhelming effect. So, in Information Technology, we apply the Magical Number 7 ± 2 in organizing very complex information systems through hierarchical structures, that is to say, initially we start only with a few things, then each of them is expandable AND contractible :)

3.3 Student-centered engagement with self-paced learning

iDEA of student-centered engagement with self-paced learning is seen through the perspective of a Frontier, customized by Applica, and content organized with Courseware. This helps promote intensive dedication to learning in a blended learning context. Self-paced learning not only helps detail-oriented learning into chosen topics (with spontaneity), but also enables online presentation that will teach others. The combination of focused study and brief presentation that creates an opportunity for teaching others with well thought out presentation also increases comprehension up to 90% (according to the Learning Pyramid). Student-centeredness also helps students experience collaborative one-on-one mentorship, individualization, customization, and increases desire for learning success. The user-centered engagement enables a “happy camper” learning experience, which is highly beneficial to learners.

iDEA-SLO conducts user-centered engagement in TWO divergent / self-paced ways: 1) Spontaneity which leads to a “teaching others” scenario through focused study and results in a revenue of 90%, and comprehensive briefness of 20% by just appreciating other topics more

with well-prepared presentations. 2) through the Magic GIFT, which is an intelligent assistant to leverage various levels of studies from junior/undergrads to senior / grads. In general, a courseware usually consists of two parts: initial, and advanced. The initial level with focus on comprehensive briefing of 20% instructs undergrads from scratch, including concepts, simplified problem-solving, etc., And the advanced level, for graduate studies, is more focused on self-taught and advanced problem-solving, illustrated in **Figure 7**.

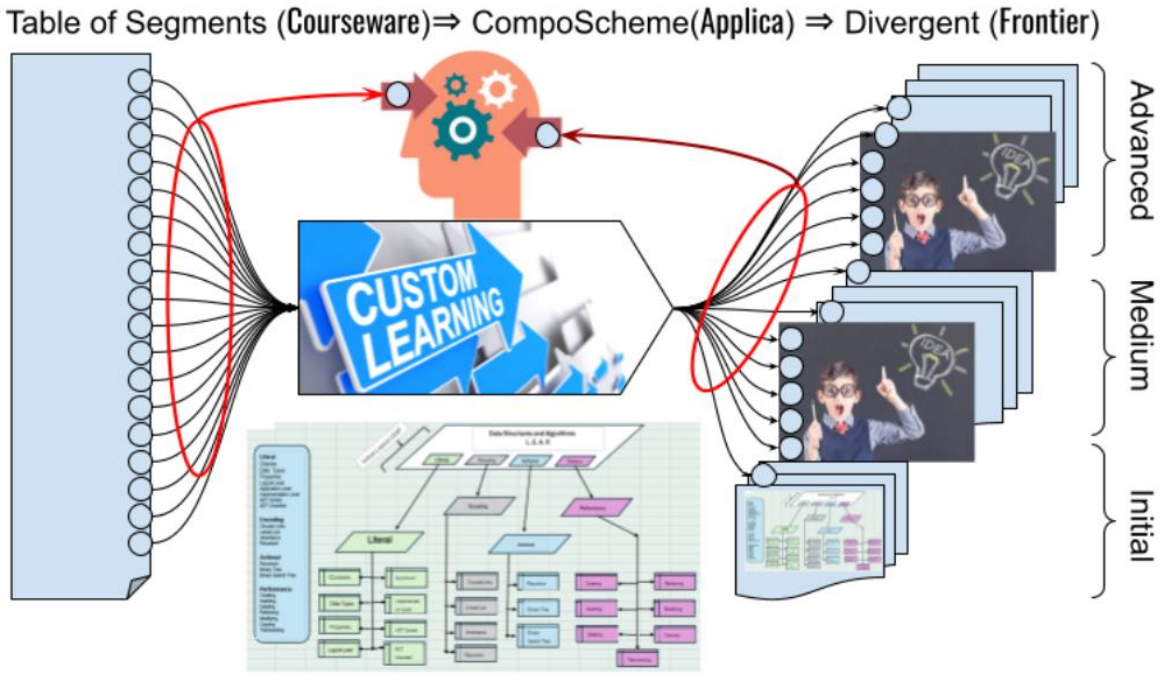


Figure 7. Convergent Intelligence into divergent instructions (student-centered engagement)

Figure 7 illustrates Applica-conducted transitioning between convergent intelligence (courseware) and divergent instructions (SLO) for the sake of student-centered engagement. In general, a courseware is designed to accommodate various levels of studies: initial, intermediate,and advanced. By use of convergent intelligence (artificial + pedagogical), the advanced level may have more focus on advanced problem-solving, the medium on general problem-solving, and the initial on conceptual via simplified samples from scratch. An expert decision service also known as a "digital twin" [9] to match up is needed to derive a specific level to accommodate diverse needs.

3.4 Computational composability for divergent outlets

Composability is another feature of computational iDEA that shows how the divergent outlet (meeting needs of three levels) can strategically be fulfilled by S4LO through Structurality,

Spontaneity, Smoothness, and Synthetics as a JIT (Just-In-Time) Outlet. Composability represents a variety of means by which a learning module is composed from the table of segments at runtime. For example, a module can comprise sections, sessions, and (hierarchical) segments. Adherence to composable rules as constituents within an expert system[20] serve to cohere or "glue" them under the module:

Segment = sections in sequence:	S_1 [&] S_2	// perform one after another
Segment = sessions in selection:	S_1 [|] S_2	// perform one or the other
Segment = subordinate seg in logic:	S_1 [%] S_2	// perform logically, but no order
Segment = subordinate seg in mixture:	(S_1 [&] S_2) [|] (S_3 [%] S_4)	

For example, segment "Actionable" usually consist of RISC & CISC, two types of computing models [21]:

Initial level: Actionable = CISC[&]RISC ⇒ students must study CISC firstly, then RISC

Advanced: Actionable = CISC[%]RISC ⇒ group-focused study + brief presentation by sharing. For instance, grad students can be divided into groups, study in depth with CISC or RISC, respectively, then share individual's observations by presenting to other groups.

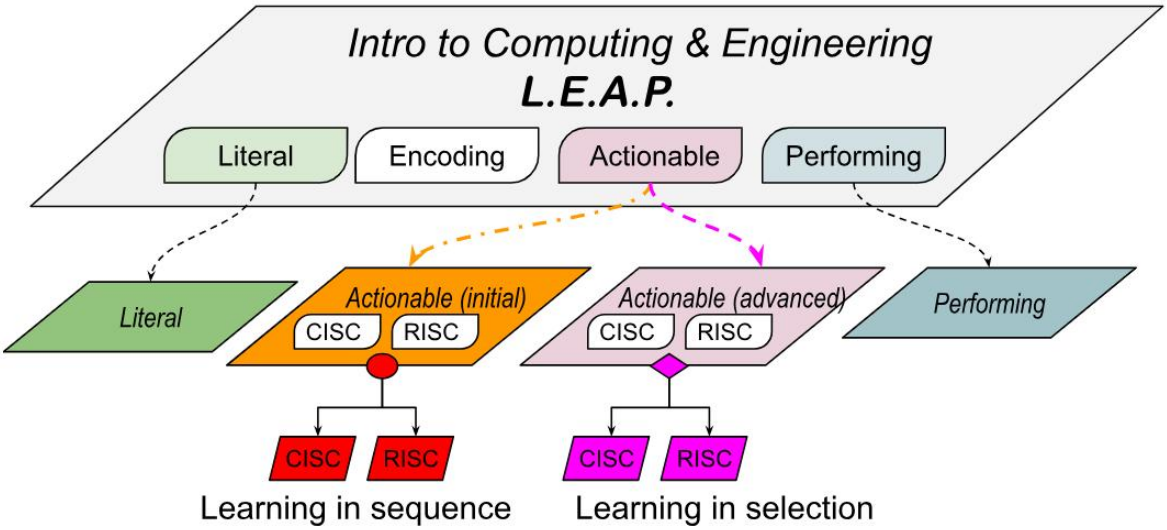


Figure 8. Computational composability diverges "Actionable" in Initial or advanced level

As illustrated in **Figure 8**, student-centered engagement is also enhanced by computational composability that accommodates dynamic learning segments for either juniors at initial level, or seniors at advanced level. "Learning in sequence" is more traditional than "learning in selection". The former is more passive in nature with regard to CISC and RISC nevertheless, students gain some conceptual understanding to a superficial degree. And, the latter creates self-paced learning. Students are grouped to select either CISC or RISC for deep learning,

which effectively creates an opportunity to teach others by sharing outcomes from their focused study (purposely gaining comprehension up to 90%). Apparently, learning-in-selection propels more retention through collaborative learning than learning-in-sequence, based on a greater commonality of knowledge between CISC and RISC. So, iDEA-SLO is smart to accommodate BOTH, period.

3.5 Case Study: Lean-tiered Outlet in USE

The outlet for sustainable learning is like a distribution storehouse having various and plentiful goods as a distribution center in the most accessible means for users to explore. A learning unit is designed as a Wi^{4}CS: web-based interactive, instructional, inspirational, intelligent and comprehensive segment that supports teaching media via presenting, playing, composing and interacting. SLO is prepared in USE (undergraduate STEAM education) with the following considerations:

- ***Wi^{4}CS*** is labeled with intelligent ingredients and stored in the cloud-based archival repository.
- ***Magic GIFT*** is an intelligent tool that applies labeled Wi^{4}CS to automate / generate various results throughout Grouping, Indexing, Folding, and Targeting.
- ***Student-centered engagement*** comes through various results or derivations for individual satisfaction.
- ***Re-grouping*** will suffice for customization based on dynamic criteria applied to Magic GIFT.

A case study is explained below to showcase how the Lean-tiered Outlet is generated via Just-In-Time (JIT), and then utilized in USE (Undergraduate STEM Education). Let's use CSC 332 Data Structures and Algorithms as an example, as shown in **Figure 9**:

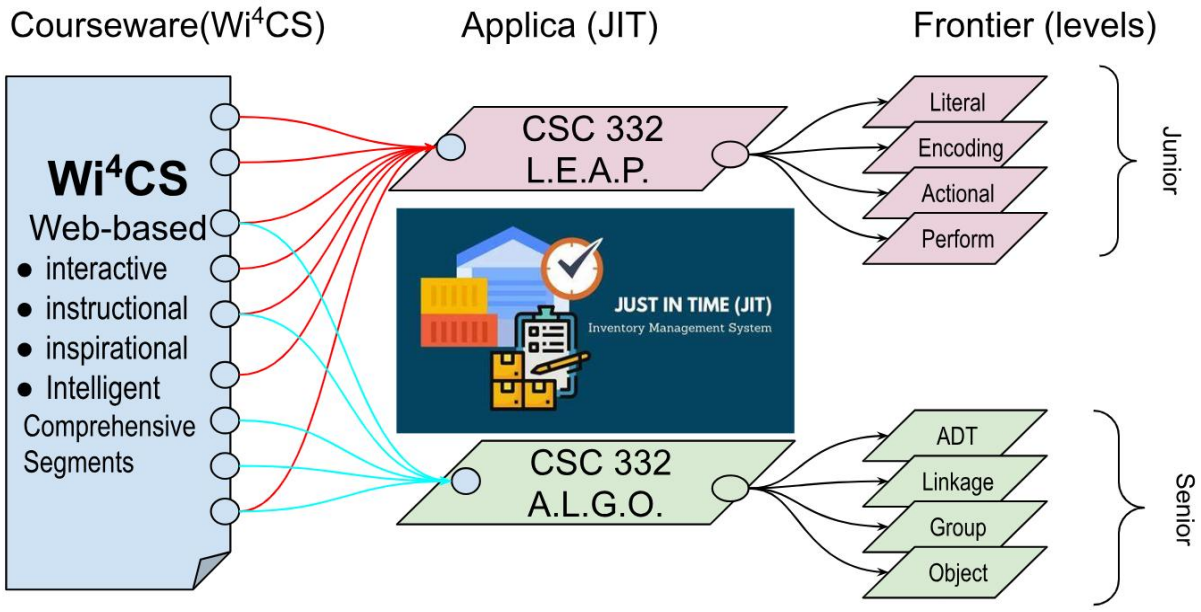


Figure 9 Magic G.I.F.T for Self-Paced Learning with LEAP and ALGO, respectively

iDEA introduces diverse syllabi and dynamic segments to support divergent learning outlets as JIT (Just-In-Time) service. It involves a set of feasible rules to drive the machine learning automaton to generate customized SLO for self-paced learning. Diverse syllabi may bring out different categories and each may have various weighted levels of learning, that is, light-weighted segments, heavy-weighted segments, and so on. Dynamic segmental means well framed categories within which segments may be composed in different ways, such as Structured in-Sequence or Spontaneous in-Selection.

In a previous journal entry, iDEAL-CIO thoroughly discussed how Magic GIFT uses various criteria to liaise with users by multiple JIT interfacing via universal interactivity with 801 web content blocks (WEBs) to which Wi^{4}CS as an heir would recruit more instruction-related intelligent ingredients for SLO in USE.

4. Conclusion

iDEA-SLO promotes the sustainability of learning with universal interactivity and user-centered engagement through the smart use of cloud-based sustainable learning outlets (SLO), so that modern learners' needs can be optimized. Collective intelligent courseware is dedicated to students through web-content boxes (WCBs) that serve them as learners with comprehensive instructional modules, operational sections, selective sessions, the derivational transitioning from the "known" to "unknown", and codified abstractions.

iDEA-SLO to innovate with LEARN (iLEARN)

SLiM-CD, or sustainable learning info management & content delivery, is productive through iLEARN as follows.

Lean tier naturally embodies "the Magical Number 7± 2" that does not challenge human cognitive capacity for processing information, but conducts smart decomposition / breakdown for reasonable comprehension given the accepted limits of human cognition, including memory and attention. This is mentally and psychologically essential for information to be processed. For example, Introduction to Computing & Engineering may involve too much information to be easily grasped at once, which would sufficiently challenge our cognitive capacity turning the manageable into a mess. It also makes sense that smart decomposition could have a variety of breakdowns, each of which dynamically reflects how to apply the magic GIFT for dynamic cognitive perspectives.

Engaging students in learning do not just rely on instruction, but also on personal interests, pedagogical inspiration, and interactivity that moves toward incremental gains of knowledge. In the past, traditional instruction became face-to-face with a high degree of attention required, as expressed in the paradox, "I hear, And I forget". However, personal interest is the key to motivation, engagement, pedagogical inspiration and to fostering a growing mindset, where interactivity plays a key role in sustainable learning because "I do. I understand." According to the learning pyramid, the practice can earn 75% of revenue, while teaching others can earn up to 90%. Apparently user-centered engagement, spontaneous options, and interactive & hands-on lab activities will more than suffice to enhance higher earning revenues.

AIM, or artificial intelligence & machine learning is central to iDEA-SLO and supports computational thinking through structure, spontaneity, smoothness and synthetic codification. Comprehensive online courseware is not designed rigidly, but as a JIT service that is smart enough to customize a learner's needs with rich digital and intelligent learning modules available at his fingertips. In addition, personal interests and interactive approach enhance and suffice for self-paced learning enjoyment.

Revenue, or learning outcomes are the only standard for verification. iDEA-SLO turns educational equity & excellence into interactive hands-on coursework - web-based interactive, instructional, inspirational, intelligent and comprehensive segments (Wi^4CS). However, as a companion, online evaluations can be made available anytime at the instructor's convenience, and anywhere when the instructor gets accessibility to the internet. Instant evaluations may

also be automated by presetting rubrics, so that teachers can more accurately assess and track a student's mastery of the material.

Novel solutions embodied by SLiM-CD are open and wise to make adjustments to potential problems because Wi[4]CS can orchestrate anything as a service (XaaS) because artificial intelligence and machine learning help establish high sustainability for lifelong learning. To reiterate, novel solutions to lean-tiered outlets for diverse and divergent needs, move students to become more engaging learners in their studies, and to the application of artificial intelligence for new problems via algorithmic machine learning. Finally, anything as a service is novel because it provides the opportunity for instant evaluations of learning activities as instant revenues as learning outcomes.

The 3-tiered framework accommodative for more STEAM subjects

Remarkably, the 3-layered framework is able to blend more STEAM subjects without much IT training required. However, the traditional syllabi (that were static, rigid, and slow to review & revise) need to be renovated in digital archives and organized in series of web based composite segments (Wi[4]CS) with intelligent ingredients attached for modularity (composable from parts), manageability (via Magic GIFT), mutability (able to change), maneuverability (universal interactivity) and so on. Extra effort should be applied toward plentiful information collected as iDEA-Knowledgebase (iDEA-Kb) so that algorithmic machine learning can apply to advance convergent intelligence for pedagogical processing, automated divergent instruction for self-paced learning approaches, and advocated lean-tier outlets for the use of the Magic GIFT at learners' fingertips. Once syllabi are renovated and arranged, they become like a living and pumping heart which sends out constantly and receives back nourished and replenished.

Certain intelligent ingredients support the sustainability of learning through the following aspects: a) Modularity - the quality of consisting of separate parts that, when combined, form a complete whole. DNA-like information should be provided, such as boundary, scoping, and subject-related keywords; b) Manageability - the quality of being easy or possible to deal with, such as extractable, embeddable, executable, and composable keys should be provided; c) Mutability - the ability to change or the fact of being likely to change, e.g, a programming module could be provided with a list of programming languages available for diverse uses by students; d) Maneuverability - the quality of being easy to move and direct.

Established iDEA Knowledgebase (iDEA-Kb) for machine learning automation

Artificial intelligence fulfillment on iDEA-SLO has been well founded through wiseCIO, DATA, and CARE, so domain-specific iDEA-Kb is presently foundational to introduce more robotic processing automation for Sustainable Learning Outlets. .

Future Work

The cultivation of the enrichment of courseware is the key to iDEA-SLO so learning segments will be collected either by contributions from experienced instructors, or discovered by digital transformation to innovate with rich courseware prepared. Relatively, current work has sophisticated solutions, such as Frontier, and Applica, so getting Courseware enriched is the foundation of S^4LO. That is, traditional syllabi for courseware have to be re-designed and altered in structural, spontaneous, smooth and synthetic threading approaches.

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