A Proposed Frameworks of the Relationships Between Instructional Design and Learning Psychology.

IJOTM
ISSN 2518-8623

Volume 8. Issue I
pp. 1-19, June 2023
ijotm.utamu.ac.ug
email: ijotm@utamu.ac.ug

JWF Muwanga-Zake
Uganda Technology And Management University (UTAMU)
Email: mzake@utamu.ac.ug

Abstract

The Tennyson and Rasch Linking Theory was fundamental in the traditional Instructional Design (ID) in that ID approached the use of ICT in learning from a needs analysis base, considered learning psychology, and then later found a suitable ICT to sort out the problems. Lately, learning has to cater for the evolution of ICTs, now in the fourth and fifth Industrial Revolutions, and for the ICT natives to whom ICTs are part of their culture, who use ICTs to learn. ID and learning facilitators then ask questions on how to use the ICT effectively in learning. This has led to unprofessional adoption of ICTs in teaching and learning devoid of considerations of learning psychology.

The evolution of ICTs forces ID to evolve and has seemingly reached crossroads between considerations of subject content, learning psychology or the curriculum and ICTs to sort learning problems out. Predominantly, ID has to evolve in concert with ICTs and their user demands, with consideration of learning psychology. The digital divide between the haves and not haves exacerbate the complexity of the cross of roads. I argue that ID faces a possibility of their roles being taken over by technologists. ID might end up as profession of evaluators of ICT in learning.

Therefore, in this paper, I review the Tennyson and Rasch Linking Theory between ID and learning psychology and re-emphasise a need to include learning psychology in ID in the adoption of ICTs to improve learning outcomes.

Key words: *Instructional Design, Learning Psychology, Industrial Revolutions, ICT Natives, Digital Divide*

Introduction

The Tennyson and Rasch Linking Theory, proposes that ID can improve learning outcomes if there is an established link between learner mental processes and the means of instruction, delivery, and assessment. Thus, the Linking Theory interrogates the ways the behavioural, cognitive, and constructivist learning theories play a leading role in ID.

A flexible delivery of learning through ICT resources to accommodate cultural variables, and recognise the specific pedagogy, learning needs, subject matter, preferences and styles of learners and particularly in online and blended courses (McLoughlin & Oliver, 2000: 1; Andrade & Alden-Rivers, 2019) is desirable. Additional considerations include, but are not limited to, technological, organisational, social, cultural, economic and teacher development factors (Minaidi & Hlapanis, 2005: 241). Thus, learning strategies are essentially a cocktail of pedagogies and ICTs particularly in developing communities, and ID ought to consider such challenges to accommodate adequately digital immigrants and citizens. Such challenges have possibly mutually led to institutional disinterest or lack of the resources and competencies to adopt ICTs (Agbo, 2005). For example, although, according to Lubega (2017), statistics indicate that there is an increasing expenditure on e-learning in several HEI, Africa still lags behind in the integration of ICT in teaching and learning with just $512 Million against, for example, USA's $27 Billion. The advancement in ICT, costs of hardware, software and internet connection are affecting greatly the adoption of e-learning.

ICTs in Learning

For some time, ICT has been recognised as the strongest factor shaping the learning landscape (Johnson, Jacovina, Russell, and Soto, 2016). Johnson *et. al.* believes that the acquisition of ICT and adapting it to curricula and integrating it to teaching present challenges to educators at each level of the learning systems. For example, there is much discussion as to what ICT adoption in learning means for pedagogy (Gregory & Salmon, 2013).

The questions on the value of ICT were answered more vividly at the advent of the Covid-19 pandemic and since then learning has been increasingly digitalised. Benefits include improving learning conditions, preparing learners for the knowledge society, enhancing classroom and school information management processes, and equity, in connecting varied income groups and with projects of learning around the world. In fact, it had been long ago recommended that ICT skills should be basic for learning facilitators (e.g., given in Pedro, Enrique, Ernesto & Lucio, 2004: iv). When teachers are digitally literate and trained to use ICT, these approaches can lead to higher order thinking skills, provide creative and individualized options for students to express their understandings, and leave students better prepared to deal with ongoing technological change in society and the workplace (Enyedy, 2014).

Learner Facilitators and Computer Use

Those who facilitate learning are the obverses of human capital production; in that they enable and improve public access to ICTs. Hence, they must be able to use ICTs and to use them to facilitate learning, to produce ICT literate workers required by the global economy. I.e., the gap educators suffer permeates through society exponentially.

However, a new survey during the Covid-19 pandemic shows that educators need new and greater professional development and support, as well as instructional tools and student-facing resources in order to be successful during remote learning (e.g., Callan, 2021). Challenges include curriculum inflexibility (e.g., timetables and workloads), understanding pedagogical theoretical frameworks and practicalities of ICTs, and inaccessibility.

One obvious remedy appears to be teacher development in ICT skills and ICT use in teaching continuously, especially because ICTs advance quite fast. But then, life-long training opportunities for educators are scarce and present multiple challenges, many of them untenable. For example, technophobic attitudes, teaching experience, knowledge and skills, as well as facilitating conditions are some of the challenges (Wu, Yang, Yang, Lu & Li,2022). Developing countries are worse off as they suffer lack of quality, illiteracy or semi-literacy; inadequate teacher preparation; and lack of leadership and control (UNESCO, 2008). Another source of rejection from imposing ICTs upon educators (Lloyd & Yellan, 2003: 92). Educators should take ownership of ICT implementation but computer issues are loci of power relationships, which determine access and the time available for educators to explore ICT uses (Watson, 2001: 259; Lloyd & Yellan, 2003).

A RARELY ATTENDED TO CHALLENGE – THE RELATIONSHIP BETWEEN ID AND LEARNING PSYCHOLOGY

The purpose of the Linking Theory is to help educational practitioners to make full use of learning theories when designing environments to improve learning (Tennyson, 2002). That is, learning theories provide the foundation for the selection of instructional strategies and allow for reliable prediction of their effectiveness (Khalil & Elkhide, 2016). Recent research on the link revealed that it is critical to ascertain which learning theory best matches an instructional situation and the background of the learners (Brieger, Arghode & McLean, 2020). Unfortunately, the link between learning Psychology and ICT is scarcely explored and applied.

Traditional Instructional Design solved specific instructional problems (e.g., Dick & Cary, 1990) by the ADDIE process, and so were mindful of the required pedagogy during the design. Currently, digital citizens and immigrants take ICTs as a way of life. Indeed, the trend of adopting new ICTs into learning tends to make ICT the problem. Thus, for example, in developing countries, research is so much about 'adoption' of an ICT or MIS than about designing ICTs suitable for learning in each given context.

It is argued that, although eventually some use of ICT is found, the current dissonance between ICT and learning is due to the trial-and-error approach, when ICT enters learning institutions without a clear idea of how or for what such ICT should be used. Hence, the statements like 'the most appropriate pedagogy for online learning is …', instead of a statement like 'the most suitable ICT for sorting problems in science is…'. ID is thus at cross-roads. There is thus a need rethink about the link between learning psychology and ID.

This paper presents the ID cross-roads pertaining to the above and advises learning systems to design technologies for each pedagogical approach and challenge, besides looking for an ICT for sorting each learning challenge and subject matter. Thus, Orlando and Attard (2015: 119) stated that "teaching with technology is not a one size fits all approach as it depends on the types of technology in use at the time and also the curriculum content being taught". In fact, there is a need to understand the purpose of an ICT as well as the stakeholders' interests, or otherwise to design and develop technologies specifically to solve teaching and learning challenges. In short, flexibility in ID is desirable to accommodate the wide spectrum of learning needs in concert with each individual learner's ICT competency and subject area.

Instructional Design

ID is instructional ICT applied to learning and teaching. Although there are several conceptions of ID, an ID approach applicable to the flexible paradigm is explained in Berger & Kam (1996) and the Applied Research Laboratory (2001) as follows:

> *Instructional Design as a Process:*
>
> ... the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. ... analysis of learning needs and goals and the development of a delivery system to meet those needs. It includes development of instructional materials and activities; and try out and evaluation of all instruction and learner activities.
>
> *Instructional Design as a Discipline:*
>
> ...a branch of knowledge concerned with research and theory about instructional strategies and the process for developing and implementing those strategies.
>
> *Instructional Design as a Science:*
>
> ... creating detailed specifications for the development, implementation, evaluation, and maintenance of situations that facilitate the learning.
>
> *Instructional Design as Reality:*
>
> Instructional design can start at any point in the design process.
>
> *Instructional System:*
>
> An instructional system is an arrangement of resources and procedures to promote learning.
>
> *Instructional Technology:*
>
> Instructional technology is the systemic application of strategies and techniques derived from behavioural, cognitive, and constructivist theories to the solution of instructional problems.
>
> *Instructional Development:*
>
> The process of implementing the design plans.

On the basis of the fundamental belief that something is a technology when it is a solution to a need, instructional technology should make learning easier and cognisant of learner's levels of ICT competencies. That is, design on the basis of learning psychology should be a more powerful influence on ID than the system that delivers the instruction. That is, ID must be flexible enough to accommodate any learner and subject.

The relationship between ID and Learning Psychology is probably implicit in Hannafin & Rieber (1989) and Thompson, Simonson & Hargrave (1992) who relate ICTs with learning. While access to information might increase the chances of learning, it is contentious whether this necessarily is transformed into knowledge. Specifically, what is the usability ICT-based information in learning? Linking ID with Learning Psychology might throw some light upon the answer to this question. ID should achieve a variety of objectives using different pedagogical strategies. Behaviourism, cognitivism, and constructivism are complimentary (Atwater, 1996) and the choice of the most appropriate ICT or mode of engaging learners should be among the last decisions to be made.

Wilson (1995) suggests praxis (interface between theory and practice), with psychologists providing knowledge on how learning could happen through ICT, and designers looking at the best ways of instruction.

ID and Behaviourism

Historically, ID was assumed to be consistent with an instructivist, behaviourist, objectivist, and knowledge transmission, in some cases borrowing from information systems processes (Hannafin & Rieber, 1989; Thompson, Simonson & Hargrave, 1992; Gagné, Briggs, & Wagner, 1992). A similar behaviourist–objectivist instructional design approach seems to be recommended in Gagné (1985: 302-329), supported by Thompson *et al* (1993: 12) who concluded that behaviourism is the most practical approach in ID. An example of such ID approaches is the Dick & Carey model (Needs analysis, Design, Development, Implementation, and Evaluation).

Procedural or programmed step-by-step instruction based on behavioural learning theories, for example of Skinner, Gagne and Rowntree, shaped the *first generation* ID, roughly during 1960-1975 (Mergel, 1998; Jacobs, 1992: 117-118). Gagne (1985), Hannafin & Rieber (1989: 92-94), Reeves (1994), as well as Burton *et al.* (2001) articulate some of the ID behaviourist models. Successful learning from behavioural ID models is demonstrated by change in behaviour of learners after using the programme (Hannafin & Rieber, 1989: 93). Thus, the learner's behaviour is predictable, can be conditioned through stimulus-response associations, using small units of knowledge and skills (Hannafin *et al.,* 1996: 379). These aggregate into a desired whole behaviour through a series of tasks to be completed by the learner during which there is reward and reinforcement in order to move forward (Reynolds, 2018). For example, the designer writes behaviourally specific learning objectives according to a taxonomy of learning types, then arranges the instructional conditions to fit instructional prescriptions. In this way, ONE can design instruction to successfully teach a rule, a psychomotor skill, an attitude, or piece of verbal information.

Learners start from easier to skills or concepts that are more difficult or complex. Tinker & Papert (1988: 5) claim that such programmes are relatively easy to create, and easy to integrate into curriculum. Examples of this include simulated actions used to train aircraft pilots as well as simulated science experiments (Linn, 1988: 122-123).

Tinker & Papert (1988: 5) argue that behavioural approaches such as simulations, tutorials, drill-and-practice are still useful in ID. Hannafin & Rieber (1989: 94) concluded that behavioural models are efficient. Nonetheless, the theorists cited in the above paragraph recommend a shift from behavioural to include cognitive and constructivist approaches.

Some Contentious Issues

The sole use of programmed learning died in early 1960s according to Mergel (1998) but in mid 1970s because it did not appear to live up to its original claims.

Among others, Hannafin & Rieber (1989), Rieber (1992), Winn (1993), Schuman (1996), Alexander (1997), Greening (1998: 29), as well as Tennyson & Rasch (1988) summarise the weaknesses of behaviourist ‘instructivist’ pedagogy. They point out objections to, more importantly, the assumption that the teacher can see further than and for the learner; that it is only effective for low-level learning such as rote recall; and that each step presented is the best one to take in order for every user. These programmes take rules, definitions, and procedures as very important. Sims (2006: 6) concludes that we do not need traditional ID, and recommends constructivist learner-centred environments for online learning.

ID and Cognitivism

An example is the Collins-Brown cognitive apprenticeship model that is tightly linked to cognitivism (Wilson, 1995). Hannafin & Rieber (1989) and Thompson, Simonson & Hargrave (1992) show developments in ID alongside psychology of learning in tandem with improvements in computer hardware and software.

Hannafin *et al.* (1996: 379) state that cognitive perspectives gained increased acceptance during 1960s because of the desire to inculcate cognitive processes, including assisting learners to form new concepts. Another essential for learning process is problem-solving. However, according to Hannafin *et al.* (2004: 6-7), there are some similarities between behavioural and cognitive programmes. For example, content is broken down and ordered in hierarchy to meet externally determined objective, and knowledge and skills are conveyed through structured means.

However, unlike behaviourist models, the focus is on the individual, and how that individual selects, perceives, processes, and learns information (Hannafin & Rieber, 1989: 94). The model stimulates cognitive processing instead of teaching. For example, some cognitive models accentuate learner-initiated inquiry, exploration, cooperative learning, and empathy, which traditional behavioural ID models do not emphasise.

Cognitive-based ID aims at learning that occurs as individuals construct ‘schemata’ that represents the world for them, and incorporates the notion of accommodation and assimilation (Gardner, 1983, 1993), and at matching learning to the individual’s needs and style of learning (Cronbach & Snow, 1977; Tobias, 1976, 1989). The Instructional Designer lists goals beyond just observable behaviour and use tools to test the newly acquired knowledge that has been "transferred" to the learner (Reynolds, 2018). Thus, ID shifted to a more systems-like design approach with a focus on the learners. The second generation is based on ‘exogenous constructivism’, by which the programme just helps learners with activities or exercises that makes them cognitively active towards new concepts and to better capacities to solve problems (Dalgarno, 2001: 185).

Features of cognitive ID models. Hannafin & Rieber (1989: 97-98) and Duffy & Cunningham (2001: 184) explain a 'cognitive apprenticeship' model, where the learner assumes responsibility although s/he is assumed to be an apprentice.

The cognitive model deals with content (as in textbooks) as domain knowledge (conceptual, factual, and procedural), but considers it insufficient to enable learners to approach and solve problems independently. The model also provides heuristic strategies that help narrow solution paths, for example, through repeated problem-solving practice. However, the learner controls most of the activities. The cognitive model recommends situated learning: that is, learning that reflects the way the knowledge will be useful in real life or authentic contexts. Duffy & Cunningham (2001: 179) advise that situated cognition should be based upon problem-solving situations. Collins gives an example in mathematics where learning could encompass shopping in a grocery store. An ICT program could be used to model such a situation, and the learners would be asked to articulate reasons for phenomena in the model. A teacher or an intelligent tutoring system gives hints to help (i.e., coaches) the learner when they are failing to solve the problem or if they are getting off-course. Cognitive ID strategies offer possibilities for transforming a learner's conceptual understanding, in a similar way practical work might.

Another important aspect of cognitive ID is that it can incorporate exploration, which encourages learners to try out different strategies and hypotheses and to observe the effects their trials. Through exploration, learners learn how to set achievable goals and to manage the pursuit of those goals - they learn to set and try out hypotheses, and to seek knowledge independently. Real-world exploration is always an attractive option; however, constraints of cost, time, and safety sometimes prohibit instruction in realistic settings. Computers offer additional advantages such as the ability to change the complexity or diversity of a situation instantly – this enables further challenges and offers grounds for testing concepts.

ID and Constructivism

From about 1989 *third generation* ID started and incorporates the learner's inputs and control of the direction of learning. It is a generation in which the constructivism aspect in the cognitive theories ("Cognitive Complexity Theory", and the "Anchored Instruction" theory) as well as the "Instructional Transaction Theory" advocating for interaction (transaction) between learner and program are applied for discovery and experiential learning in computer "micro worlds"(Rieber, 1992; Wenger, 1987; Merrill, 1991, 1993). Learners chose what to learn.

Instructional Design and Learner-Centredness

There is no doubt that ICT, and in particular web-based or online ICT has enhanced learner-centredness and redefined ways of searching for information. Unfortunately, it is often taken for granted that technologies can simply enhance learning (Kirkwood & Price, 2014: 6) once presented to learners such that ICT, learning enhancement, and learner engagement are mutually and indissolubly linked.

Yet, for example, online, or digital inhabitants have been observed to be locally anti social, preferring to share information virtually, oblivious, apparently, of physical realities such as the people and information in their surroundings. Little or no socially face-to-face enhanced learning happens – i.e., no social constructivism happens. The competition for attention between lectures and these virtual resources is challenging when learners chose virtual resources in place of physically present lecturers (Shimabukuro, 2005). Additionally, digital inhabitants demand instant gratification, offered by for example playing games.

The advancement in computers caters for Gardner's Multiple Intelligences (MI) in the *third generation* ID, providing instructional designers with many approaches to a topic. Examples include:

- **Linguistic** and communication tools: E.g., Word processing
- **Logical-Mathematical** (Logic and critical thinking skills): E.g., exploring, organizing data, programming, selecting relevant information and problem solving while playing a game
- **Visual/Spatial** and theory-building tools: E.g., microworlds, graphing utilities, modelling environments, creativity and visual skills; browsing through a 3-D programme
- **Musical:** E.g., composing music
- **Bodily-Kinaesthetic:** E.g., hand-eye coordination with the keyboard and the mouse; moving objects around the screen
- **Interpersonal:** Working in groups in microworlds
- **Intrapersonal:** E.g., working independently at own pace

It is not clear where the *third generation* ends (and whether that is important), but beyond the *third generation*, use of computers in learning focused attention on interactive multimedia in which learners control what they do in a constructivist framework (Alexander, 1997), with the assumption that learners know best their needs. There seems to be cognitive constructivist models, which Papert (1993) argues are "dirty" (holistic and authentic), as opposed to behavioural approaches, which Papert terms "clean" teaching (isolate and break down knowledge to be learned). Cognitive-constructivist models view truth and knowing as local events, and highlight the importance of context and multiple perspectives in making meaning (Willis, 2000: 5), all of which can be disorganised (dirty).

The *fourth generation* rejects cognitive science as the **only** (my emphasis) basis for instructional design, and the exclusion of the learner from planning or designing the learning experience. It relies on 'endogenous constructivism' by which learners discover and explore virtual environments (Dalgarno, 2001: 186). Constructivist experiences help learners to understand what they are studying (Salviati as cited in Cunningham, 1991: 130), because, through participation, such experiences embody iterative use of knowledge and skills for further experiments and experiences (Winn, 1997). The design permits learners any kind of interaction the system is capable of (Jacobs, 1992: 119; Merrill, 1993; Young, 1996: 18), instead of prescriptions. The importance of context, and of social construction imply that **any** (my emphasis) model made by learners is just one of the many possible constructivist ID models (Willis, 2000: 9-12; Kozma, 2000: 13).

The fourth generation ID ushers in the use of microworlds and open environments into ID, and offers opportunities for a wider range of learning strategies including constructivism.

Microworlds, Virtual Environments, and Virtual Realities

Microworlds

Jonassen *et al.* (2003: 90) state that Papert and the MIT Media Lab started the use of the term 'microworld'. A microworld is an exploratory learning environment that simulates phenomena, thus offering opportunities to learners to manipulate, explore, and experiment. A microworld is also known as a simple domain, focussing on the quality of a few interrelated constructs (Hannafin *et al.*, 1996:393). Other examples of microworlds or "phenomenaria areas" appear in Perkins (1991: 19), and include "aquariums", "SimCity", and "physics microworlds". Computer microworlds offer virtual environments and realities in which one can do many things, some of which are beyond reach in real worlds.

Manipulating the equipment, the task, and the environment control the complexity in a microworld. Thus, *successful microworlds rely on learners regulating and controlling their own learning* (Jonassen *et al.,* 2003: 191). For example, microworlds can incorporate cognitive apprenticeships, which provide *opportunities for modelling, reflection, exploration,* and for a learner to reflect on his/her knowledge. Or can *contain adventure games, where players master each environment before moving on to more complex environments* (Jonassen *et al.*, 2003: 191).

The importance of microworlds is that they are more open for learning than, for example, laboratories, that are defined by pre-specified objectives. With these features, microworlds can qualitatively alter a learner's conceptions (Hannafin *et al.,* 1996: 393). Playing games in such microworlds is an example of applications of radical constructivism (Rieber, 1992: 94).

McLellan (2001: 457) notes that 'virtual' *denotes the computer-generated counterpart of a physical object,* and Rieber (1992: 94) describes VEs as … *computer-based learning environments* ... Jonassen *et al.* (2003: 201) describe VR as … *a type of microworld that provides learners with an interactive 3-D experience by surrounding them with a moving simulated world.* However, I take virtual environment as the space in which virtual realities happen or exist. A microworld generated by a computer then has space, which I refer to as the virtual environment (VE), and objects as well as activities, which I refer to as virtual realities (VR).

Virtual Environments (VEs)

Learners enter into an artificial microworld, which has VEs (Hannafin & Sullivan, 1995; Winn, 1996). The advantage of VE microworlds is that they cannot be provided by any other means (Winn, 1993). For example, computers can enrich VEs and extend our perceptual, tactile, and visual insight into concepts (Kiboss, 1998: 12). VEs can be used to teach science concepts, which are difficult to teach in real laboratories because learners interact iteratively with virtual objects in conditions, which are possible only in a virtual laboratory (Perkins, 1991; Ramsey, 1975:98-99; Dede, 1995; Winn, 1997; Geelan, 2000). Overall, access to knowledge and interactions are unrestricted in VEs, and offer open environments, possibly as described by Doll (1989: 246), that are useful for modelling (Stratford, 1997: 4-12), and encourage what Yore (2001) refers to as interactive constructivism. However, there are complaints that VEs have suffered prevalence of ICT and aesthetics rather than promoting knowledge – they simply supply information without knowledge-building processes (Barbera, 2004, 14).

Open Learning Environments (OLEs) - OLEs are enabled in VE.

It seems that the notion of an open learning environment, as described by Doll (1989: 246), Hannafin, Hall, Land, & Hill (1994: 48), as well as Hannafin *et al.* (2004: 7), is constructivist since such an environment grants learners their wishes, but allows inputs from a facilitator and/or the programme. The constructivist design anchors learning activities to the learner's long-term or larger problems, but in a form authentic, and therefore open, to a learner (Savery & Duffy, 1995: 32-33). Rieber (1992:94), Hannafin (1999) as well as Savery & Duffy (1995) explain further that an environment is open if it allows a learner to chose interactions, goals, and /or the way to pursue those goals. The focus is on an individual's understanding, needs, perceptions, and experiences. Thus, Hannafin (1999) adds that OLEs guide learners to recognise or generate problems that relate to their needs.

Virtual Realities

Virtual Realities (VR) have tended to redefine ID (and probably teaching) towards:

- No rules or procedures/ processes. ICT is used by a trial-and-error approach;
- Learners becoming co-designers albeit without experience of ICT applications and curricula in transforming information into knowledge;
- ICT playing a leading role in determining pedagogy; and
- Pedagogy being redefined at a rate commensurate with technological change.

While VR could offer voluminous information, the ability for learners to use that information to learn and to face-to-face debate issues is questionable. In that regard, Glogoff (2005) wonders whether virtual communication can lead to useful virtual communities. A computer game based upon mixed epistemologies (pre-determined behaviourist pathways, with some cognitive and constructivist learner-centred activities) seemed to be adequate in addressing school learning and teaching problems in Biology in SA (Ivala, 1998; Adams, 1998: Muwanga-Zake, 2007).

The advent of virtual reality (VR) boosted the fourth generation programmes (Winn, 1993). Computer-generated microworlds provide VR in which there are opportunities for exploration (Cohen, Tsai, & Chechile, 1995) of phenomena that would be difficult, or intangible under usual laboratories. Additionally, traditional lessons sometimes lack real-life analogies on which to build mental models, because there are no such events in the real world (Dede *et al.,* 1997).

Jonassen *et al.* (2003: 201) explain that an outstanding feature of a good VR is 'immersion'. Dede (1995), (Osberg, 1997), as well as Moshell, Hughes, & Loftin (1999) add that immersion in VR can provide the subjective impression that one is participating in a "world" comprehensive and realistic enough to induce suspension of disbelief. That is, the user becomes isolated from the real environment and interprets the images in the VR as being real. This makes the user interact intuitively like an inhabitant of the VR.

According to Dede (1995), Zeltzer (1992), and Dede, *et al.* (1997), VR improves learners' understanding relative to other technologies because VR accommodates autonomy, presence, and interaction. That is, VR can engage learners with experiences, which facilitate perceptual experiences. Thus, VR supports constructivist learning (Greening, 1998). The theorists in this paragraph also believe that another useful characteristics of VR for learning is that it motivates a learner by inducing him/her to spend more time and to concentrate on a task. I think these are ways the designers of Zadarh used VR.

VRs face difficulties of cognitive load. For example, there is a difficulty of *switching attention between the different senses for various tasks* (Dede, 1995). Hence, Dede (1995) advises for taking care of speed.

Games in VE and VR microworlds

Various authors (E.g., Linn, 1988: 128; Leutner, 1993: 113; Tinker & Papert, 1988: 3-7; Greening, 1998; Dede, *et al.*, 1997) elaborate on constructivist microworlds that include games. The process of playing the game is constructivist in that the learners are co-designers (design to learn kind of approach), but should be guided. These authors advise that the game should be interesting with graphics that is appealing and music. There has to be a defined start and finish of the game, and an overall floor plan or map.

Instruction and Construction?

It is notable that instruction and construction appear to be antagonistic such that there could be tension between classical (traditional) ID and the newer radical constructivist approaches in ID.

Constructivist OLEs are Chaotic

Openness brings with it multiple demands, since each learner might have different desires and methods of learning. Thus, Wilson (1996) believes that among the difficulties with open environments is the possibility that they might be fuzzy and ill defined, but argues that an environment that is good for learning cannot be fully packaged and defined. Learners might chose activities, pace and direction, to the extent that the end outcome is uncertain and uncontrolled. Thus, Winn (1997) as well as Hannafin (1999) point out that strategies for providing guidance, feedback to actions and collaboration, are not so straightforward.

Wilson (1996), Dede (1995), and Perkins (1996) note differences in the amount of guidance or direct instruction found in learning environments, and observe that varying degrees of guidance pose different instructional challenges. According to Wilson, the teacher or instructional designer has to be tentative to accommodate learner freedom. Learners can be provided with perspective-setting or -altering contexts that help to activate relevant prior knowledge, experience, and skill related to the problem and to potential strategies to be deployed (Hannafin, 1999).

Wilson observes that the same chaos (desirable in OLEs) is also characteristic of poorly designed OLEs – i.e., it might be difficult to know whether the chaos is intended or is a result of poor design. For example, when learners get lost or stranded, one need to find out whether this is designed to help them solve a problem or it is due to lack of support.

Hannafin *et al.* (1996: 395) as well as Hannafin, Hannafin, Land, & Oliver (1997: 107) discuss this apparent tension at length. For example, Hannafin *et al.* (1997) argue that Gagne's instruction model takes *reality as objective and independent of the individual learner*. On the other hand, constructional design creates environments in which a learner can design his or her own tasks and constructs. Thus, *the term 'instruction' is considered a pejorative to some in describing emerging learning systems* (Hannafin *et al.,* 1996: 395).

Hannafin *et al* (1997: 113-114) and Schuman (1996) advise inclusion of aspects of each learning theory because each theory has strengths and weaknesses. In support, Ertmer & Newby (1993) and Davidson (1998) point out that learning theories are compatible with ID, such that Scott, *et al.* (1987) talk of the application of constructivism in instructional design with reference to games.

Prescriptive vs. Post-Modern Models

In the future, instructional designers are likely to choose one of two paths: specialist or generalist. In the prior path, designers would focus on one aspect of learning or instruction and act as consultants or subject matter experts. The other approach is one more aligned with managerial activities. Since the field is becoming too broad for most designers to work with authority in all matters, this option allows practitioners to oversee the development of instructional projects, rather than narrow their efforts exclusively on assessment, analysis, design, development, implementation, evaluation or continuous improvement (Leigh, .

There is no doubt that ICT, and in particular web-based or online ICT has enhanced and redefined the way learners and educators look for information and do research. While access to information might increase chances of learning, what is in contention is whether the increased access to information has necessarily improved learning and therefore the acquisition of knowledge.

This, while worth further research, faces also the arduous task of evaluating the quality of knowledge; for example, usability of such knowledge. Online, or digital inhabitants are characteristically locally anti social. Watch learners absorbed into their mobile devices and social media oblivious, apparently, of people they are sitting with and what those people might know. Put a computer in front of a learner, and you compete with virtual phenomena on the computer for attention. Digital inhabitants demand instant gratification. Alas, they socialise over distance or in virtual spaces perhaps, but seemingly rarely share their information with individuals in their physical spaces for face-to-face debate. So, with whom would this kind of learner share information to solve local problems?

The Fourth Industrial Revolution and on

Developing countries are challenged by a mixture of industrial revolutions. For example, within the same country in African countries parts don't have any industrialisation whilst others are already embracing the fourth and fifth industrial revolutions. ID in such instances is challenged with providing solutions to learning challenges using different levels of ICT.

Importantly, learning should be able to utilise even the latest computer technologies if the graduates are to be expected to use these in their work. For example, while one can use Artificial Intelligence (AI) to write essays and rephrase academic papers, ID should devise ways by which AI could instead assist learners how to write good essays. But this implies that ID practitioners understand how AI works so they can call upon AI specialists to help address the technology dimension as presented in Figure 1. So, ID practitioners must keep abreast the developments in computer science – thus, a course on developments in computer science is necessary for ID. This advice is in concord with Minaidi & Hlapanis's (2005: 241) view that adopting ICT in learning *can be influenced by technological … and teacher development factors.*

Table 1 illustrates a matrix of ID and learning psychology.

		Learning Paradigm		
Instructional Design		**Behaviourism:**	**Cognitivism**	**Constructivism**
		Assumption: Learners'/ students' brains are blank slates – must be guided to knowledge. Instructivist, objectivist, knowledge transmission, mainly borrowing from information systems processes = change in behaviour Example: Pavlov (classical conditioning), Skinner (operant conditioning), Gagne and Rowntree	Assumption: Learners develop through cognitive stages and can think by themselves Learner assumes responsibility to learn Learners reflect on their experiences, create mental representations, and incorporate new knowledge into their schemas. Example: Piaget, Gestalt (response to situations)	Assumption - learners know best their needs. 'Endogenous constructivism' - learners discover and explore environments Learners build/ construct their own understanding. Example: Dewey, Piaget, Vygotsky, Gagne, and Bruner
	Example Model	Dick & Carey model (Needs Analysis, Design, Development, Implementation, and Evaluation) (ADDIE) Laboratories, that are defined by pre-specified objectives.	LOGO Collins-Brown cognitive apprenticeship model	MIT Media Lab Papert (1993) - Virtual Reality Games/ microworlds. "aquariums", "SimCity", and "physics microworlds".

	Sample activities	Didactic - Teach a rule, a psychomotor skill, an attitude, or piece of verbal information	Dialogue – develops schema A learner selects, perceives, processes, and learns – transforms information to applicable knowledge Consider Gardner's multiple intelligences.	Dialogue – internal and external. Can be intuitive – guess work. Scaffolding Enhanced opportunities in line with Garner's multiple intelligences: • **Linguistic** E.g., Word processing • **Logical-Mathematical – E.g.,** exploring & organizing data, • **Visual/Spatial** E.g., 3D modelling • **Musical:** E.g., composing music • **Bodily-Kinaesthetic:** E.g., moving objects around the screen • **Interpersonal:** Working in teams • **Intrapersonal:** E.g., working independently at own pace

	Design	Stimulus-response; Procedural or programmed instruction Simulations Closed systems	Enhanced learner-centredness Cognitive development through stages from simpler to more sophisticated Problem-solving – critical thinking of/ about problems Interaction (transaction) between learner and program. Provocative and divergent open-ended questions; Team works; feedback to review, refine, and improve understanding Multiple contexts and perspectives in making meaning Semi open – some guidance	Dirty (holistic and authentic) - offers environments for each level of conceptual development (each learner unique). Problem-solving – critical thinking in constructing meaning. Co-construct – social and cognitive constructivism. **Provocative scenarios to generate actions or discussion** (E.g., 'what if' pathways). Team works; instant feedback to refine pathways. Manipulating equipment or objects – varied complexity in a microworld. • No rules or procedures/ trial-and-error approach; • Learners co-designers in transforming information into knowledge; • Pedagogy being redefined at a rate commensurate with technological change. Open system.

	What does the designer do?	Offers prescribed and preconceived pathways. Offer practice Writes behaviourally specific learning objectives, classifies those objectives according to a taxonomy of learning types, then arranges the instructional conditions to fit the current instructional prescriptions Isolate and break down knowledge to be learned)	Design discovery and experiential learning in computer "micro worlds" Offer practice for desired competencies/ skills Programs that can change the complexity or diversity of a situation instantly Enable challenges and offer grounds for testing concept Open but guided systems that provide opportunities for modelling, reflection, exploration	Offer microworlds - phenomenaria areas Designs virtual exploratory environments Offer experiences of virtual reality. Permits learners any kind of interaction the system is capable of Open Learning Environments (OLEs) - Open systems that allow any explorations.
	Expectations/ Outcomes	Behavioural changes. Remembering Advanced psychomotor skills developed.	Cognitive apprenticeship success. Accentuated learner-initiated inquiry, exploration, cooperative learning, and empathy Debate; Analysis; Application Own ways of searching for information - set achievable goals and to manage the pursuit of those goals	Device ways of solving problems on his/her own. Evaluation-Synthesis-judgement Debate Exploration, learners try out different strategies and hypotheses and observe the effects their trials Free (unguided) explorations and choices

THE CROSSROADS - AN ALTERNATIVE APPROACH TO INSTRUCTIONAL DESIGN

Figure 1 shows that competency in subject content and ICT, as well as well-designed curriculum are all concomitantly necessary for successful Instructional Design.

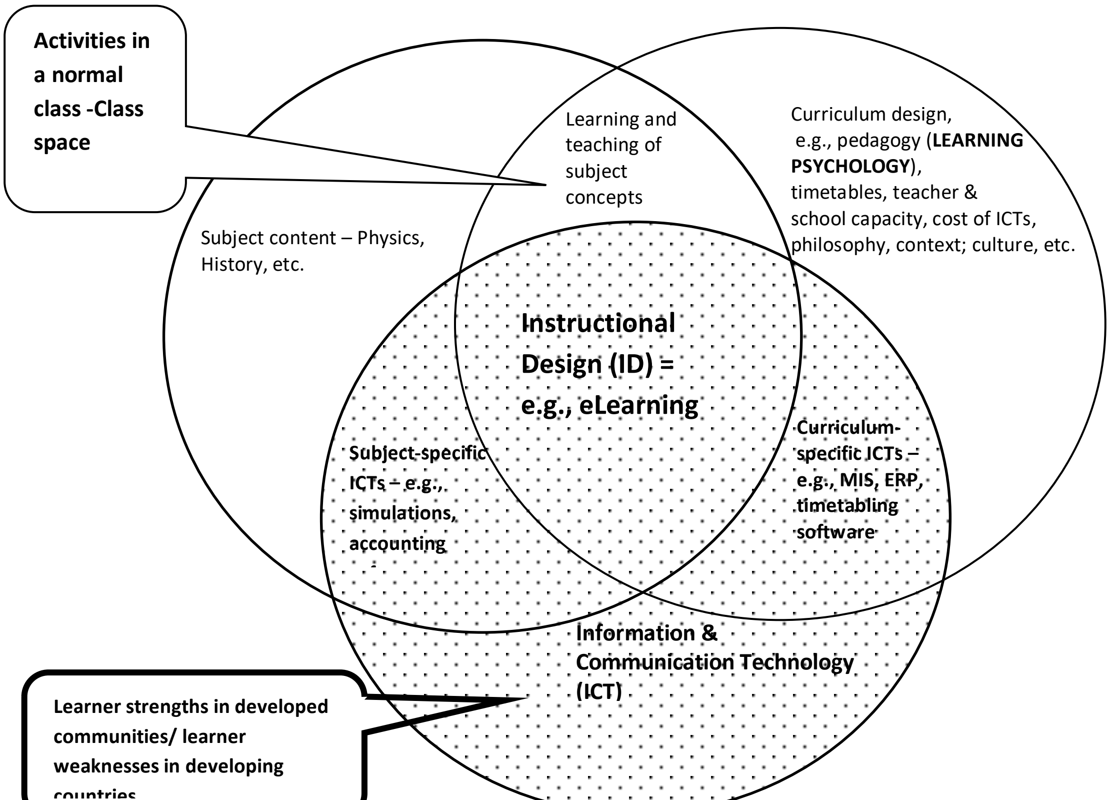

Figure 1. Components of Instructional Design

Problems that ID is supposed to sort cover all the three subsets in the Venn diagram – Figure 1. Figure 1 seems to imply that the evolution of ID is essentially in concert with three major learning theories, behaviourism, cognitivism, and constructivism. ID has faced crossroads of ICTs versus learning theories versus subject content to the extent that all learning theories might be represented in a single eLearning program.

THE FUTURE

Much time is spent on teaching staff and learners 'how' to use ICT. But this is in many institutions to the level of delivery of information – not so much on how ICT could scaffold learning (i.e., turn information into knowledge). The cost of ICT makes it inaccessible to individuals: it is the same cost that inhibits schools from using ICT. Institutions of higher learning therefore pose as experts only because people cannot afford the ICT. Should ICT become reasonably cheap, institutions would then have no claim on expertise on ICT because learners would come to, for example, universities, when they do know how to use most ICT. Then courses on ICT would probably reverse back to mainly examining and finding pedagogical uses. ID would have gone full circle, towards solving learning and teaching problems.

References

Agbo, I. S. (2015). Factors Influencing the Use of Information and Communication Technology (ICT) in Teaching and Learning Computer Studies in Ohaukwu Local Government Area of Ebonyi State-Nigeria. *Journal of Education and Practice* www.iiste.org ISSN 2222-1735 (Paper) ISSN 2222-288X (Online) Vol.6, No.7, 2015

Andrade, M. S, & Alden-Rivers, B. (2019). Developing a framework for sustainable growth of flexible learning opportunities. *Higher Education Pedagogies*, 4:1, 1-16, DOI: 10.1080/23752696.2018.1564879

Berger, C. and Kam, R. (1996). Definitions of Instructional Design. (Adapted from "Training and Instructional Design". *Applied Research Laboratory*, Penn State University). Online: http://www.umich.edu/~ed626/define.html [11th August 2007]

Brieger, E., Arghode, V. and McLean, G. (2020). "Connecting theory and practice: reviewing six learning theories to inform online instruction", *European Journal of Training and Development*, Vol. 44 No. 4/5, pp. 321-339. https://doi.org/10.1108/EJTD-07-2019-0116

Callalan, E. (Feb., 2021). New Study: Teachers Also Suffering from Digital Divide in Pandemic: Remote Learning Challenged Educators, Exacerbated Inequities Among Students. New Study: Teachers Also Suffering from Digital Divide in Pandemic: Remote Learning Challenged Educators, Exacerbated Inequities Among Students (wgbh.org)

Dick, W. & Cary, L. (1990), *The Systematic Design of Instruction*, Third Edition, Harper Collins

Enyedy, N. (2014). *Personalized Instruction: New Interest, Old Rhetoric, Limited Results, and the Need for a New Direction for Computer-Mediated Learning*. Boulder, CO: National Education Policy Center.

Gagné, R. M. (**1985**). *The Conditions of Learning and Theory of Instruction*. New York. Holt, Rinehart and Einston.

Gagné, R. M., Briggs, L. J. & Wagner, W. W. (1992). *Principles of Instructional Design* (4th ed.), Holt, Reihhart, and Winston Inc.

Greening, T. (1998). Building the Constructivist Toolbox: An Exploration of Cognitive Technologies. *Educational Technology/March-April 1998.*

Gregory, J., & Salmon, G. (2013). Professional development for online university teaching. *Distance Education*, 34(3), 256–270. doi: 10.1080/01587919.2013.835771

Hannafin, M. J. & Rieber, L. P. (1989). Psychological Foundations of Instructional Design for Emerging Computer-Based Instructional Technologies: Part I. *Educational Technology, Research and Development. 37 (2), (91-101).*

Johnson, A. M., Jacovina, M. E., Russell, D. E., & Soto, C. M. (2016). Challenges and solutions when using technologies in the classroom. In S. A. Crossley & D. S. McNamara (Eds.) *Adaptive Educational Technologies for Literacy Instruction* (pp. 13-29). New York: Taylor & Francis. Published with acknowledgment of federal support.

Khalil, M. K. & Elkhider, I. A. (2016). Applying learning theories and instructional design models for effective instruction. *Advances in Psychology Education.*

Kirkwood, A., & Price, L. (2014). Technology-enhanced learning and teaching in higher education: What is 'enhanced' and how do we know? A critical literature review. *Learning, Media and Technology*, *39*(1), 6–36. doi:10.1080/17439884.2013.770404

Lubega, J. (2017). The Role of ICT in Africa's Evolving Higher Education Sector *RUFORUM Communication* October 24, 2017. Annual General Meeting 2017

McLoughlin, C., & Oliver, R. (2000). Designing learning environments for cultural inclusivity: A case study of indigenous online learning at tertiary level. *Australasian Journal of Educational Technology*, *16*(1). https://doi.org/10.14742/ajet.1822

Orlando, J., & Attard, C. (2015). Digital natives come of age: The reality of today's early career teachers using mobile devices to teach mathematics. *Mathematics Education Research Journal, 28*, 107–121. doi:10.1007/s13394-015-0159-6

Perkins, D. N. (1991). Technology Meets Constructivism: Do They Make a Marriage? *Educational Technology.* Vol. 31(5). May 1991 18-23.

Reynolds, J-E, (March, 2018). Implications Of Learning Theories on Instructional Design. *Instructional Design.* eLearning Industry. https://elearningindustry.com/learning-theories-instructional-Design-implications

Rieber, L. P. (1992). Computer-Based Microworlds: A Bridge Between Constructivism and Direct Instruction. *ETR & D Vol. 40 No. 1*

Savery, J. R. & Duffy, T. M. (1995). Problem Based Learning: An Instructional Model and Its Constructivist Framework. *Educational Technology/September-October 1995. pp 31-37.*

UNESCO, Global e-Schools and Communities Initiative (2008). Main issues, possible solutions and opportunities for ICTs. Microsoft Word - Main issues_doc_update.doc (unesco.org). https://en.unesco.org/icted/sites/default/files/2019-04/main_issues-possible_solutions_and_opportunities_for_icts.pdf

Tennyson, R. D. (2002). Linking Learning Theories to Instructional Design. *Educational Technology*. Vol. 42, No. 3 (May-June 2002), pp. 51-55 (5 pages). Published By: Educational Technology Publications, Inc.

Thompson, A. D., Simonson, M. R. & Hargrave, C. P. (1993). *Educational Technology. A Review of the Research.* Revised Edition. Washington. Association for the Educational Communications and Technology.

Wilson, B. G. (1996). Maintaining the Ties Between Learning Theory and Instructional Design. Paper presented at the meeting of the *American Educational Research Association*, San Francisco, March 1995. Online. [Available] http://www.cudenver.edu/~bwilson [8th October 2002]