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Evaluating the Utility of a Knowledge Acquisition and Construction Framework for Learning Management Systems

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Abstract

Virtual Learning Environments (VLEs), also known as Learning Management Systems (LMSs) are being implemented by many higher education institutions in response to the increasing demand for online teaching and learning. Open source software platforms such as Moodle, Sakai and Claroline are among the most commonly implemented approaches. This paper offers a comparison and evaluation of some of the popular VLEs/LMSs and on the strength of such analyses, establishes the desired properties of a LMS to organise the learning process in Open and Distance e-Learning (ODeL). Following this, the extent to which a previously developed Knowledge Acquisition and Construction framework of the authors adheres to an ideal LMS, is evaluated.

Keywords: Constructivism, framework, Learning Management System, *my*Unisa, Moodle, Open and Distance e-Learning (ODeL), online, Sakai, Virtual Learning Environment.

Introduction

With the rapid advances in Internet technology and the world-wide web, higher education institutions have increasingly shifted their teaching and learning foci to open and distance e-learning (ODeL) and the accompanying online technologies (Guri-Rosenblit, 2009). In order to manage the multitude of technologies available to e-learning providers, Learning Management Systems (LMS) (there are more than 250 LMS on the market) have been developed during the past fifteen years as platforms to handle student registrations; course management and delivery; assessment; and reporting (Bri, Garcia, Coll, & Lloret, 2009). The target market includes multinational corporations, universities and government agencies. Bri et al. (2009) also report that a good LMS can, amongst other, increase the productivity of instructors and managers, improve on learning results and reduce costs of compliance.

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In 2004, the University of South Africa (Unisa) (http://www.unisa.ac.za) took a decision to migrate from previous disparate Learning Management Systems to a new integrated Learning Management System that was branded '*my*Unisa'. Subsequent to this decision, the Sakai Framework was adopted in June 2005, and six months later, user testing, based on this platform, was in progress (Myburgh & Sithebe, 2006). The *my*Unisa e-learning environment has evolved steadily over the past 8 years up to what it is now, and it continues to evolve into the future as it adapts and incorporates changing circumstances. The *my*Unisa system is available to registered students at https://my.unisa.ac.za/.

According to Liebenberg, Chetty, and Prinsloo (2012), 282 248 students had access to the *my*Unisa e-learning environment in 2011 out of a total of 328 179 registered students. The *my*Unisa e-learning environment consists mainly of teaching and learning tools among other features. The university encourages such environment to be the primary and official means of communication between lecturers and students, e-tutors and students, and among students themselves. An e-tutor project started in 2013 and each new student is linked to an e-tutor at registration (Van Schoor, 2013).

Learning Management Systems (LMSs) and Virtual Learning Environments (VLEs)

The literature makes no definite distinction between a Learning Management System (LMS) and a Virtual Learning Environment (VLE). Technology platforms that support online teaching and learning use several (loosely equivalent) names such as: Learning Management Systems (LMSs), collaborative learning environments, course management systems and Virtual Learning Environments (VLEs).

The following definitions have been put forward:

- A *Virtual Learning Environment* (VLE) is a system that allows for learning materials to be made available to learners via the world-wide web. Typical services offered include collaboration and communication tools; student tracking and maintenance; and assessment (McGill & Hobbs, 2008).
- A *Learning Management System* (LMS) is a system which distributes interactive media, establishes channels of synchronous and asynchronous communication, manages the learning process and facilitates the participation of students and teachers in an integrated way (Alves, Miranda, Morais, & Alves, 2012).

Subsequently in this paper we adopt the terminology of an LMS to interchangeably denote a VLE as well. Hence, the *my*Unisa system may be viewed as an instantiation of an LMS/VLE. In this paper we evaluate three prominent LMSs, namely, Sakai on which *my*Unisa runs and the Moodle and Claroline platforms. We also evaluate the extent to which a previously developed framework of the authors (refer to the Appendix) satisfies the design principles of the LMSs presented in this paper. The framework in the appendix was developed following extensive literature reviews on ODeL and the requirements gathered of such a framework. The framework was developed in Kashora, van der Poll and van der Poll (in press).

The paper is organised as follows. The research questions underlying this work are given next, followed by the research methodology and analyses of three LMSs. The philosophies driving each of the Sakai, Moodle and Claroline platforms are discussed and these are compared with reference to their different attributes. We establish some desired properties of an LMS and argue to what extent the Knowledge Acquisition and Construction Framework in the Appendix satisfies such an ideal LMS. The paper concludes with a summary and directions for future work.

Research Questions

This paper aims to find answers to the following questions:

RQ1: What are the differences, advantages and disadvantages of three prominent and widely used LMSs?

RQ2: To what extent does our Knowledge Acquisition and Construction framework satisfy the requirements of an ideal LMS?

Research Methodology

This work forms part of a larger study which seeks to explore how Unisa students experience and evaluate online learning in Management Accounting. The research uses a descriptive phenomenological approach in order to answer the questions posed during the study. Research in essence, is a systematic investigation that seeks answers to a problem (Blaxter, Hughs & Tight, 2010). Penner and McClement (2008) recommend the use of a descriptive phenomenological approach when little is known about the topic under investigation. Online learning is a fairly new field; there is a need to understand the lived experiences of those learners in the field. Online web-based courses have advantages in that (i) learning can take place for as long as there is an Internet connection (learning any place, any time), and (ii) instructors can with reasonable ease upgrade and manage learning materials on the web.

Philosophies Driving Some Learning Management Systems

Numerous Learning Management Systems are used in higher education, government and the corporate world. Examples of these LMSs are Moodle, Sakai, Blackboard, Claroline, Ilias and Desire2Learn. In this paper the Moodle, Sakai and Claroline platforms are discussed and compared. These three platforms have much in common: Each has its roots in academia; each of these is based on an open-source portfolio; each has a modular architecture; each supports the popular standards of the SCORM (Sharable Content Object Reference Model) and each utilises efficient communication channels which encourage collaboration and interaction among students and instructors. One of the important outcomes emanating from these features is the efficient management of teaching, learning and research, both for on-site and distance learners.

In general, a Learning Management System should support the following: (Alves et al., 2012):

- A centralised and automated administration.
- Self-services (preferably self-guided).
- Rapid assembly and delivery of learning content.
- Scalable web-based consolidation of training initiatives.
- Portability and adherence to standards, such as Sharable Content Object Reference Model (SCORM).
- Personalisation of content and enabling of knowledge reuse.
- Distribution of teaching aids and managing course content: A VLE allows students access to important course components, e.g. syllabus, additional reading, workshops, tutorials etc. Students should also be able to download learning materials such as images, audios, videos and animations.
- Announcements: VLEs allow instructors to contact individuals, groups or the whole class enrolled for a specific course.
- Discussion forums: These allow participants, both students and instructors, to contribute discussions on the topic(s) raised.

- Submission of tasks: The e-learning platform facilitates instructor access to materials uploaded by the students, and vice versa; students can access their marked assignments and the solutions to assignments.
- Evaluating learning progress: VLEs provide for the development of online assignments, tests and exams, as well as setting dates and the time when students can take such assessments.
- Monitoring student activity per course: VLEs can maintain class lists, as well as other information like email addresses etc. Instructors can check the number of times that a particular student accesses a course or forum, and the duration of each access.

Next we give a brief introduction to the three (3) LMSs addressed in this work.

Moodle

Moodle started off in academia, and continues to be a major player in the higher education market. Moodle is more pedagogy oriented while Sakai is more oriented towards collaboration (see below). Moodle is an acronym for "Modular Object-Oriented Dynamic Learning Environment". It is an open-source course management system that was designed using known pedagogical principles, and aimed at helping educators to create effective online learning communities (Bri et al., 2009). Moodle is programmed in PHP and it can, in principle, be installed on any computer that runs PHP. Moodle is a very popular free Course Management System (CMS). The choice of a LMS is of relevance for any e-learning project that is intended to deliver didactic modules for higher education.

Below are some characteristics of the Moodle platform (Bri et al, 2009):

- Promotes social constructivist pedagogy, consistent with the stipulation of the framework at level 1 (refer to the Appendix).
- Is suitable for online delivery and it can supplement face-to-face learning.
- It is easy to install on almost any platform that supports PHP. It requires just one shared database.
- It supports full database abstraction in the sense that it caters for all major brands of databases.
- Course listings give information of every course on the server, including accessibility to guests.
- Courses can be categorised and indexed – a single Moodle site can support very many courses.
- Security is maintained throughout.
- Most text may be edited via an embedded WYSIWYG HTML editor.

Generally, Moodle is ideal for lower resource organisations such as schools, small businesses, non-profit organisations, and local government agencies. One criticism sometimes levelled against Moodle is that it has many buttons and functionalities which allow for complex functions, yet complicating simple tasks (Lebrun, Docq & Smidts, 2009). Another criticism is that its implementation code is untidy because of very many open-source developers over its development period.

Sakai

Sakai is another free and open source platform that was built, and is maintained by the Sakai community. Sakai was developed by a consortium of five US Universities during 2004 and, presently, it is managed by the Sakai Foundation. It was first released to the public in 2005. Sakai is programmed in Java, it uses a modular architecture (Bri et al., 2009) and it aims to integrate train-

ing and communication capabilities (Alves et al., 2012). It is popular for its high-end features, scalability and security features which are discussed in a next section.

While Moodle is more pedagogy oriented, Sakai is more oriented towards *collaboration* among the facilitators and the learners.

The *my*Unisa e-learning environment is powered by Sakai, therefore the features and tools of the Sakai Framework determine the tools and features of *my*Unisa.

Claroline

Claroline was developed mainly from 2001 – 2002 and its aim was to promote pedagogic innovation at the Universite Catholique de Louvain (UCL) in Belgium (Lebrun et al., 2009). Claroline, like Moodle, was developed in PHP, and released under an open source GPL licence. It has a modular design and it complies with SCORM requirements. Compliance with SCORM enables programs to run on different LMSs, and to use the Sharable Content Objects (SCO) in different course structures. The source code is clear, thereby facilitating the development of new functionalities. It is more learning-oriented rather than being communication-oriented. Claroline was developed following teachers' pedagogical experiences and needs (Lebrun et al., 2009). It allows course managers to set up efficient resources aimed at knowledge and skills acquisition, and uses technology as a support for pedagogy. The framework (refer to the Appendix) offers several opportunities to incorporate technology at the implementation stage (wikis, podcasts, video and Skype technology).

The methodology adopted by Lebrun et al. (2009) for Claroline is depicted in Figure 1. It shows information interacting with activities (abstraction, analysis, synthesis, evaluation, and critical thinking) as the learner constructs knowledge.

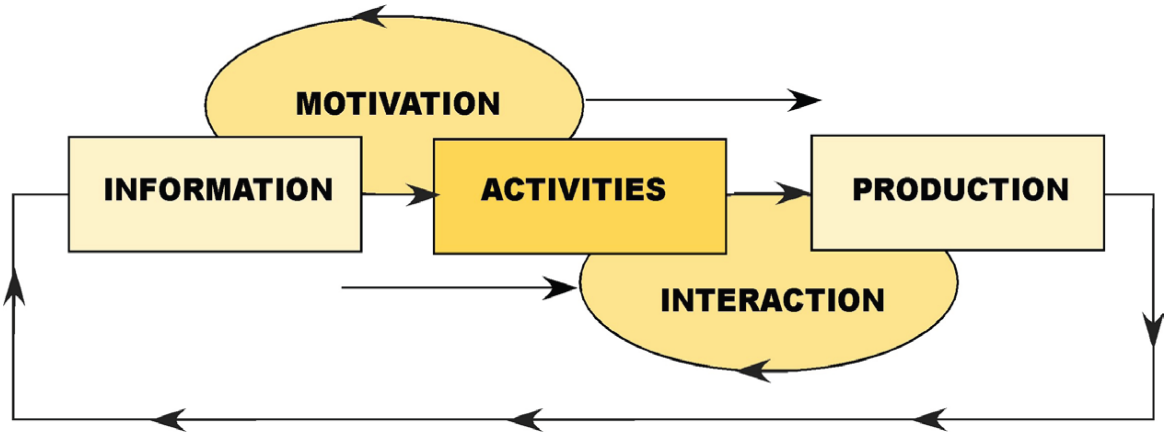

Figure 1: An ICT-based pedagogical development model (*Source:* Lebrun et al., 2009).

Figure 1 is inspired and informed by a constructivist approach: information is, via students' activities transformed into knowledge, which feeds into a next set of information gathering processes (Lebrun et al., 2009). The framework recommends constructivism as the theory of choice when it comes to technological applications and implementations; an often cited outcome of this approach is the deep understanding of the concepts at play.

Bri et al. (2009) confirm that the effect of ICT in producing more active learning methods is substantial. To this end a LMS like Claroline facilitates the use of experimental methods by a lecturer in pedagogical innovations.

The Claroline platform is based on the teacher's needs which include (Consortium Claroline, 2006):

- Publishing documents and announcements,
- Giving students tools to develop activities and to demonstrate their skills,
- Allowing interactions among students and with teachers.

Next we compare the above LMSs, using mainly the criteria in Fakhreldeen (2013).

Comparing the 3 LMSs – Moodle, Sakai and Claroline

First we perform comparisons with respect to system requirements and architecture.

System Requirements and Architectures

Table 1 shows the underlying system *architectures* associated with each.

Table 1: System requirements for Moodle, Sakai and Claroline

NO	SYSTEM REQUIREMENTS	MOODLE	SAKAI	CLAROLINE
1	*Database*	*MYSQL, ORACLE*	*MYSQL, ORACLE*	*MYSQL*
2	*Operating system*	*ANY*	*UNIX, WINDOWS*	*LINUX*
3	*Programming language*	*PHP*	*JAVA*	*PHP*
4	*Web server*	*ANY*	*APACHE*	*APACHE*
5	*Application server*	*PHP4*	*TOMCAT*	*APACHE*

Source: Adapted from Fakhreldeen (2013)

From Table 1 we infer:

Programming language comparisons are complicated to some extent since Sakai is written in Java; the other two are written in PHP. Consequently, different system requirements (e.g., operating system or web/application server) may result.

Apart from the Application Server, the Moodle LMS appears to be the most versatile of the platforms since it supports the largest variety of system requirements.

Philosophies

Table 2 presents some of the common *philosophies* for Moodle, Sakai and Claroline.

The following may be inferred from the literature and Table 2:

- Suri and Schumacher (2008) confirmed in a survey on Sakai, Moodle and Blackboard that Sakai is simpler to use but lacks some of the richer functionality available in Moodle and Blackboard (not part of our study). However, some users argue that, naturally, with improved functionality, Sakai could become highly competitive. There is, therefore, a need to improve on the Sakai platform in order to have the capacity to respond to new educational requirements.

Table 2: Philosophies driving the learning management systems

NO	FEATURE	MOODLE	SAKAI	CLAROLINE
1	Open-Source Portfolio	Y	Y	Y
2	Modular Architecture	Y	Y	Y
3	SCORM Compliant	Y	Y	Y
4	Communication Channels	Y	Y	Y
5	Collaboration & Interaction	Y	Y	Y
6	Manage Teaching, Learning & Research	Y	Y	Y
7	On-Site and Distance Support	Y	Y	Y
8	Constructivist Theory	Y	Collaboration	Y
10	Client-Server Architecture & Cloud	Y	Y	Y

Source: Adapted from Fakhreldeen (2013)

Further Metrics of Comparison

Table 3 shows additional metrics to be used in a comparison of the three LMSs.

Table 3: Metrics for comparing the learning management systems

NO	METRIC	MOODLE	SAKAI	CLAROLINE
1	Support	Y	Y	Y
2	Security	Y	Y	Y
3	Ease of use	Y	Y+	Y+
4	Management	Y	Y	Y
5	Interoperability	Y	Y	Y
6	Flexibility	Y	Y	Y+
7	Performance	Y+	Y	Y
8	Communication tools	Y	Y	Y

Source: Adapted from Fakhreldeen (2013)

In Table 3, "Y" represents an acceptable level (a qualitative measurement) of the metric while "Y+" represents an even higher score on the same scale.

The following are inferred:

- Sakai and Claroline score higher than Moodle in the category "Ease of use".
- Claroline measures best on "Flexibility".
- The "Performance" score of Moodle is the best of the three LMSs.

Verdict

The three platforms Moodle, Sakai and Claroline each have many good features on offer; some score better than the others. The features are given in tables 1 – 3 and the syntheses following each.

Ideally, an LMS should be developed that includes the best features of the three platforms combined – Moodle is preferred when it comes to system requirements and architectures; Sakai appears to be best with respect to the underlying philosophies (Table 2), while Claroline appears to be preferred when it comes to the metrics in Table 3. Therefore, each platform has something unique to offer, hence we call for the development of a (new) LMS that incorporates the best features (and scores) of the three LMSs.

The above discussion answers our 1st research question (**RQ1**).

Before we investigate the extent to which our Knowledge Acquisition and Construction Framework in the Appendix satisfies the design principles of the above three LMSs, we present some further insights into Sakai, the platform on which the *my*Unisa system of a large ODeL institution (Unisa) has been implemented.

Sakai Learning Platform

Sakai is considered to be the best of the three LMS above with respect to its reporting features. This holds also for the relative ease in which it may be customised and rebranded (Table 3), and for its collaboration characteristics (Table 2).

Bri et al. (2009), however, report that Sakai falls short on profiling and management. They also report it to be challenging in integrating Sakai with other enterprise software systems. Another disadvantage usually associated with most open-source Learning Management Systems is that each can cost as much or even more than a commercial product. In particular, the costs for technology procurement and maintaining the infrastructure; training staff; and ongoing support may be as high as for a commercial product. Despite these drawbacks, the Sakai e-learning Platform continues to penetrate the higher education market at an increasing speed.

Despite the above disadvantages, the Sakai e-learning Platform has, therefore, distinguished itself from the competition by displaying some attractive characteristics. In this regard, the following are reported by various sources, notably, the International Institute of Informatics and Systemics (http://www.iiis.org/) and Bri et al. (2009):

- General student and lecturer collaboration features, e.g., wikis; course management and announcements; RSS feeds, etc.
- Typical teaching and learning characteristics which allow for lecturers to plan and construct lessons, create and assess assignments and share documents via cloud drop boxes. Naturally, the use of cloud technology (e.g., drop boxes) is essential in ODeL.
- Administrative management and Portfolio tools.
- Sakai has an initial list of options from where it is possible to access different learning resources (learning materials, discussion forums, notices, tasks, assessment tests, etc.).
- The Sakai 2.5 e-learning platform assigns each group a private folder that enables members to upload and download homework, assignments and specific documentation – another requirement of ODeL.
- The Sakai LMS allows lecturers to upload multiple documents simultaneously.
- The Sakai platform has a ‘Student’s Portfolio’ which can be customised by each student and be used to present course work and projects.

- Sakai 2.5 LMS provides each user with a particular directory to share information with other students enrolled for the course.

Next we evaluate the extent to which our framework for Knowledge Acquisition and Construction in the Appendix satisfies the design aspects of the LMSs addressed in this paper. Such framework was first developed in Kashora, van der Poll and van der Poll (in press), and its utility in terms of *technical subject* activities was illustrated in Kashora, van der Poll and van der Poll (2013).

Evaluating the Utility of the Framework for a LMS

Our framework contributes to the design principles of the LMSs through:

1. *Skyping*: The framework encourages the use of Skype.
2. *Teaching and learning (T&L):* The Knowledge Acquisition and Construction Framework addresses a number of requirements as reported on by Alves et al. (2012). These include the use of synchronous (videoconferences, real-time chats, whiteboards etc.) as well as asynchronous (e-mails, blogs, wikis, podcasts, discussion forums, etc.) communication tools. The majority of these are also part of (e.g.) the *my*Unisa system on Sakai. Every student has a *my*Unisa email profile (*my*Life) and can communicate with administration and other registered students.
3. *Constructivism*: The Knowledge Acquisition and Construction Framework may assist students with their learning programs. For example, the constructivist theories may be employed to encourage students to construct their own ideas, meaning and understanding. The above T&L interactions (point 2) are premised on the theories of constructivism.
4. *Acquiring ICT skills*: Lecturers are to be assisted by improving on their ICT skills through pedagogical innovations. The *my*Unisa platform has an abundance of technology-rich functionalities. The lecturers need to be prepared to implement new methods that use ICTs. Such innovative ways would empower the lecturer as well as his/her methodologies in terms of technology. The framework acknowledges these requirements.
5. *Scaffolding*: The *my*Unisa platform has an Additional Resources section which often contains additional material to elaborate on subject concepts. This is an example of a learning scaffold as suggested in the framework.
6. *Endless repetition*: The framework encourages "practising endless repetition". The assignments and past examination questions on the *my*Unisa platform can fulfil this function for distance learners (users).

The above answers our 2nd research question (**RQ2**).

Conclusions and Future Work

This paper evaluated three (3) Learning Management Systems, also known as Virtual Learning Environments. The Moodle, Sakai and Claroline platforms were evaluated with reference to their system requirements and architectures; underlying philosophies; and a number of additional metrics like ease-of-use, flexibility, performance, etc. It was found that each of the three platforms outperforms the other two in at least one of the features mentioned. Subsequently we suggested the design of a LMS that incorporates the best features of the three platforms.

Our framework for facilitating Knowledge Acquisition and Construction was evaluated with respect to the properties of the LMSs investigated in this work. It was found that the framework indeed incorporates many of the properties of a good LMS. The use of the Knowledge Acquisi-

tion and Construction Framework could facilitate organising a complex subject like e-learning, which is evolving and changing as a result of adopting new technologies and new forms of learning.

To the knowledge of the authors, little research has been done on how students experience and evaluate online learning. Hence, future work in this area will be to enhance the framework in the Appendix. This will be through qualitative surveys among the lectures and students of some undergraduate Accounting courses at Unisa (University of South Africa), a large role player in the ODeL arena.

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Biographies

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Appendix A

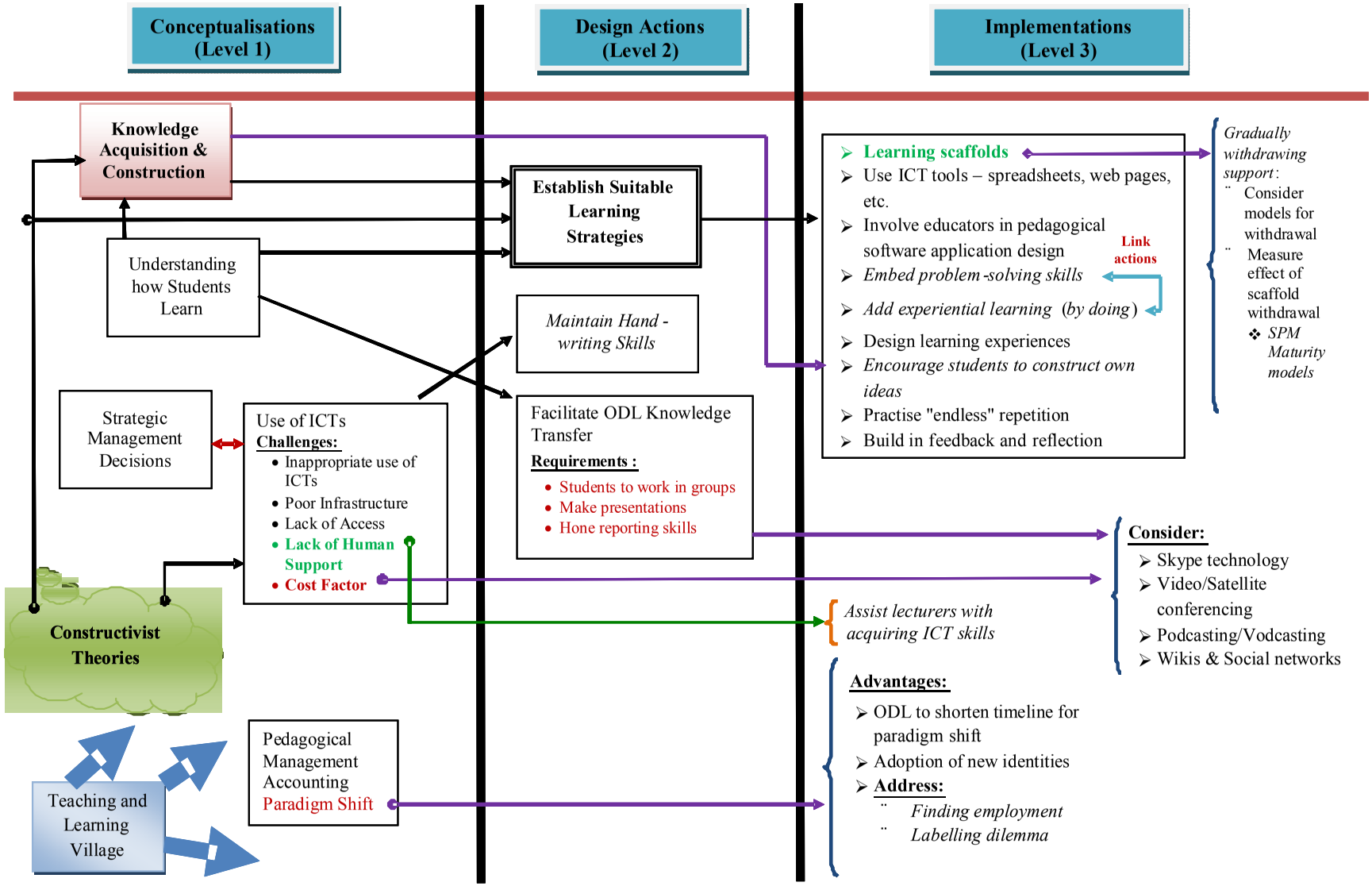

Figure 2: Knowledge Acquisition and Construction Framework