Forms of Formative Assessment in Virtual Learning Environments

Full Papers

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Abstract

One of the challenges in the contemporary education is improving learner's learning capability during the learning period through formative assessment in virtual learning environments. The formative assessment process requires learner to be active participants in the learning process by communicating and interacting with the instructor. The formative assessment process accommodates learner responses that give an opportunity to support the learner in learning through feedback. In a virtual learning environment, formative assessment can be significantly improved by the use of information systems. In this research we explore forms of formative assessment in virtual leaning environments with a specific focus on the design dimension. Our analysis improves the understanding of formative assessment and the design dimension specific to forms of formative assessment in virtual learning environments. Our work informs the design of online learning environments to improve the effectiveness of formative assessment.

Keywords

Virtual learning environment, Formative assessment, Information systems, Forms of formative assessment.

Introduction

Education today significantly depends on technology which has changed teaching and learning, delivery of learning material, access to learning resources, virtual learning environments, and assessment. Assessment is a core function in education process where formative assessment has been used to improve learning and summative assessment has been used to evidence learner knowledge at a particular time (Duchesne et al. 2013). Since computer based learning and virtual learning environment (VLE) have become the norm today, VLEs must cater for both formative and summative assessments (Ćukušić et al. 2014). Formative assessment in VLE accommodates learner inputs, facilitates learners with technological capabilities, and is increasingly becoming relevant to today's educational environments.

There are range of views of formative assessment in a VLE, including but not limited to online formative assessment, e-learning formative assessment, and assessment for learning (Gikandi et al. 2011). All of these approaches emphasize a learner focused approach, interaction between the learners and the instructor, collaboration and communication, flexibility, improve learning through feedback, and dependency on technology.

Our investigations were unable to find a comprehensive study making explicit definition of formative assessment in the design dimension of a VLE. It is noted that the research investigating formative assessment in the design dimension of a VLE is still in its infancy. Non availability of such research is further contributed by the complexity of the dynamic changes in technology, hence an opportunity for

new research. Additionally, technology facilitates the use of media consisting text documents, audio clips and video clips. Traditional face to face lectures are recorded by the use of technology. Significant number of universities records their lectures and makes them available to students for later viewing which they use for their learning. Most of such processes are informal and therefore not seen as formal processes. However, we believe such learning activities contribute substantially to learning. Accordingly, due to the importance of design of a VLE and the relevance of the formative assessment in today's education, our research investigates the nature of formative assessment in the design dimension of VLE. Consequently, our primary Research question: *What are the attributes of formative assessment in the design dimension of a Virtual Learning Environment*?

Our initial concepts are extracted from the prior research which consist of; a learning model, technology, learner control, content, and interaction (Piccoli et al. 2001). We then adopted an exploratory research approach to allow the flexibility needed to accommodate any new findings into the existing knowledge base. Our research found four VLE design dimension attributes that can explain the nature of formative assessment in a VLE. The research contributes by presenting a conceptual framework for formative assessment and exploring different types of formative assessment. We explain formative assessment by mapping newly evolved attributes into formative assessment phases. The research improves our understanding of the formative assessment in a VLE. Understanding can be further improved by studying different forms of formative assessment. Such improved understanding is critical when current research is staggered or when in the early stages of development.

Next we present the background of the research concepts consisting VLEs, formative assessment, educational success, and Information Systems (IS) research. After the background section, we present the research process, research design, and research development. Then we discuss reliability and validity, discussion, contribution and concluding remarks.

Background

Virtual Learning Environments

Virtual learning environments (VLEs) are viewed as, "*computer-based learning environments which are relatively open systems, allowing interactions and encounters with other participants, resources, and representations. …. in a virtual environment, they interact primarily with other networked participants, and with widely disseminated information tools.*" (Piccoli et al. 2001; Wilson 1996). VLE uses technology as a medium in the learning process where communication, interaction, and access to resources are significantly improved through the information systems. For example, VLE allows synchronous communication and asynchronous communication, flexible with the learning location through the internet, and improves access to learning resources.

VLEs are seen as technology based learning which share attributes of online learning, e-learning, technology mediated learning, technology based learning, and web-based learning (Gikandi et al. 2011). Even though there are common attributes, diverse terminologies used as given above could create confusion among researchers. For example, there are several terminologies used in relatively related research consisting but not limited to; e-learning (Ozkan and Koseler 2009), technology mediated learning, (Bitzer et al. 2013) electronic classroom (Leidner and Jarvenpaa 1995), virtual learning environments (Piccoli et al. 2001), educational virtual environments (Mikropoulos and Natsis 2011), and online learning (Guo et al. 2012). Further, VLEs are viewed as, computer-based environments that are relatively open systems, facilitating interactions among participants in the learning process and providing access to a wide range of resources (Wilson 1996). VLE's encourage learners to be more technology savvy so that they are more knowledgeable about virtual learning experiences. However, VLEs demand learners be more responsible and have more control over time, place, and the space in their learning (Piccoli et al. 2001). In summary, VLEs facilitate communication between the teacher and the learner, integration of learners with learning processes, access to learning resources, and can be used as a medium in the learning process. Accordingly VLE functionalities suggest that learning can be significantly improved with the help of IS.

Formative Assessment

Formative assessment is seen as classroom assessment, teacher-assessment, and assessment for learning (Black and Wiliam 2009; Gulikers et al. 2013). Formative assessment does not have an explicit definition which could create poor understanding of formative assessment (Oxenford-O'Brian 2013). In an effort to understand formative assessment, we investigated it's core functionality. The primary objective of formative assessment is to improve learning during a learning period primarily through feedback. Formative assessment must consists of following key functionalities (Ramaprasad 1983).

- Establish current state of the learner (in their learning goal)
- Establish where they are going (goal)
- Establish what needs to be done to get them to the goal (how to fill the gap)

The objective of the formative assessment is improving learning and the nature of formative assessment could vary depending on the learning goal. However, the core functionality of the formative assessment must not change. For our research, we adopt a refined definition of formative assessment as, *"a process during the learning period which consists of setting a learning goal, systematic activities used for gathering information about the progress of the learning, then analysing that information, drawing inferences, feedback, and taking appropriate actions to improve learning" (Berry 2008; Oxenford-O'Brian 2013).* In a Virtual learning environment, formative assessment functions through digital media consisting (but not limited to) highly improved functionalities in information availability, communication, and interaction. Even though the learning goal guides the formative assessment process, learners must be successful in learning outcome. Finally, the objective of formative assessment is to improve learning processes to achieve more successful outcomes. Accordingly we present a description of educational success below.

Educational Success

Educational success refers to the outcome at the end of the learning period which can be indicated collectively by educational performance, learning satisfaction, and efficacy (Piccoli et al. 2001). Educational performance is indicated by the results from summative assessment. Learner satisfaction is the perceived learning experience of the learner. Efficacy refers to the level of confidence of the learner in learning. Self-efficacy and technology-efficacy are the confidence in learning and confidence in technology respectively.

IS Research in education and online learning

IS research is viewed as a multi-disciplinary and inter-disciplinary research domain (Levy and Ellis 2006). Development of IS in education is extensive which reflects from the uses of IS in online-learning, e-learning and web-based learning systems. Formative assessment, can be a formal or informal process (Ćukušić et al. 2014). Managing informal processes can be challenging in any environment, so it is necessary that we recognise the nature of these informal processes. Therefore we need to use multiple approaches to capture and analyse both the formal and informal process data (Gikandi et al. 2011).

Research Process and Research Design

Research Process

Our objective is to understand the nature of formative assessment in the design dimension of a VLE. Literature review helps to understand the existing knowledge and provides a solid foundation to the research to develop further. To accommodate current research and to allow new findings, we adopt an exploratory research method. Accordingly, initial investigations included literature reviews and preliminary interviews and focus group discussions. IS literature has unique characteristics and therefore literature review need to follow a systematic data processing approach (Levy and Ellis 2006). Consequently, we adopt the approach suggested by Levy and Ellis for IS research (Levy and Ellis 2006). Processed followed during literature review is shown in figure 1 below. Accordingly, our initial literature review focused on the key words derived from the research question which consists of "formative assessment", "virtual learning environment", "online learning", and "design dimension".

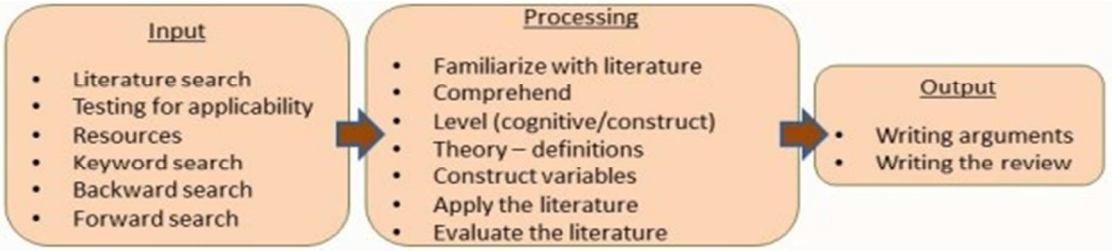

Figure 1: Literature Review Process (based on (Levy and Ellis 2006))

Preliminary searches were limited to high ranking journals such as MISQ and ISR as they were considered as prominent journals in the information systems research (AIS 2015). We used forward and backward searches and the resulting articles were filtered to the keywords extracted from the research question (Levy and Ellis 2006). Selected articles were studied in-depth to familiarize and comprehend. At the end we found 62 VLE articles, 51 formative assessment articles, and 65 e-learning articles. Some articles were in multiple-categories. Based on the relevance to our research and the comprehensive work, we find Piccolli (1991) provide the foundation for our research (Piccoli et al. 2001). Once this part is finished, we developed a conceptual framework. Then the process continued with interviews and focus group discussions. Participants are students and instructors from tertiary educational institutions. All participants have experience in e-learning systems in different levels/roles such as learners, tutors, lecturers, and course coordinators. Interview sessions were recorded with permission, and transcribed after the session. We conducted preliminary 16 interviews of approximately 45 minutes each. Two focus group employed 5 individuals and each required approximately one hour session. Interviews continued until no new findings are evolved. It was decided to conclude the interviews at this point and analyse the data collected.

Exploratory interview questions primarily focused on the formative assessment process and information systems. Specific attention was paid to the core functions of formative assessment currently in practice in VLEs. These core functions are: establishing the current state (setting goal, data collection, and analysis), feedback, and action. Interview data has been processed through thematic analysis (Braun and Clarke 2006). After searching for themes we conducted two focus group discussions to explore interview findings further. However, focus group discussions did not change the outcome from the interviews rather it confirmed the themes evolved from the interviews. At the end, results helped us to develop a conceptual framework for formative assessment in VLE.

Attributes from Virtual Learning Environments

We extracted VLE attributes from formative assessment process with the help from both the literature and interviews. The table 1 below presents these attributes, references, and a description.

Attributes	**References**	**Attributes description and Literature/ Interview notes**
Communication	(Gikandi et al. 2011; Piccoli et al. 2001; Wilson 1996)	Communication refers to the messages passed between the learner and the instructor through electronic media. "*VLEs can foster communities of learners and encourage electronic interaction and discussion. In a VLE, the learning … … can incorporate and leverage the many-to-many relations among learners and with instructors.*" Comment: "*.. Feedback be in a form… so that it is quickly given to the student*".
Interaction	(Gikandi et al. 2011; Piccoli et al. 2001)	Interaction refers to Learner's active interaction with others (instructor, peers, system) in learning process. • e-Learning system facilitate interaction between participants in learning through online classes, emails, and discussion boards. • Engagement and immersion. • Student interacts with the learning system for self-assessment.

		"*Interaction between student and the teacher is important in learning improvements. When learner asks questions, teacher can understand the knowledge of the student. Technology helps learners to interact with the teacher and peers where email, chat, and forums are useful*".
Learning Model	(Leidner and Jarvenpaa 1995; Piccoli et al. 2001)	Primary learning models in education are objectivism and constructivism. Depending on the learning goal, the learning model is selected. Constructivism includes but not limited to collaborativism, socioculturism, and cognitive information processing.
Learning Space	(Piccoli et al. 2001; Proserpio and Gioia 2007)	Learning space refers to the learning resources facilitated through the e-learning system including reading material, exercises, , chat rooms, discussion forums, and processes for learning. • Learning space includes formal and informal learning activities. • Flexibility: Example can be the accessibility to the e-learning system through different browsers. • Ability to lead: Learner or instructor leading the process. If the learner posts a question in the discussion board that is answered by the instructor/peers. Similarly instructor can lead the learning process by posting a question to simulate learners' thinking. "*In a VLE, the learner will be provided resources through an online learning environment. In addition, online environment could help conducting online learning sessions, wide range of resources, and increase students' learning resources".*

Table 1: Design Attributes of Virtual Learning Environment within formative assessment

Conceptual Framework for Formative Assessment

As explained above, the formative assessment in VLEs are influenced by IS enabled communication, interaction, learning model, and learning space.. Consolidating our observations, first we present the abstract view of the formative assessment process and attributes of formative assessment in a VLE. The figure 2 below presents a conceptual model, the scope of the research, and is the foundation for proposition development.

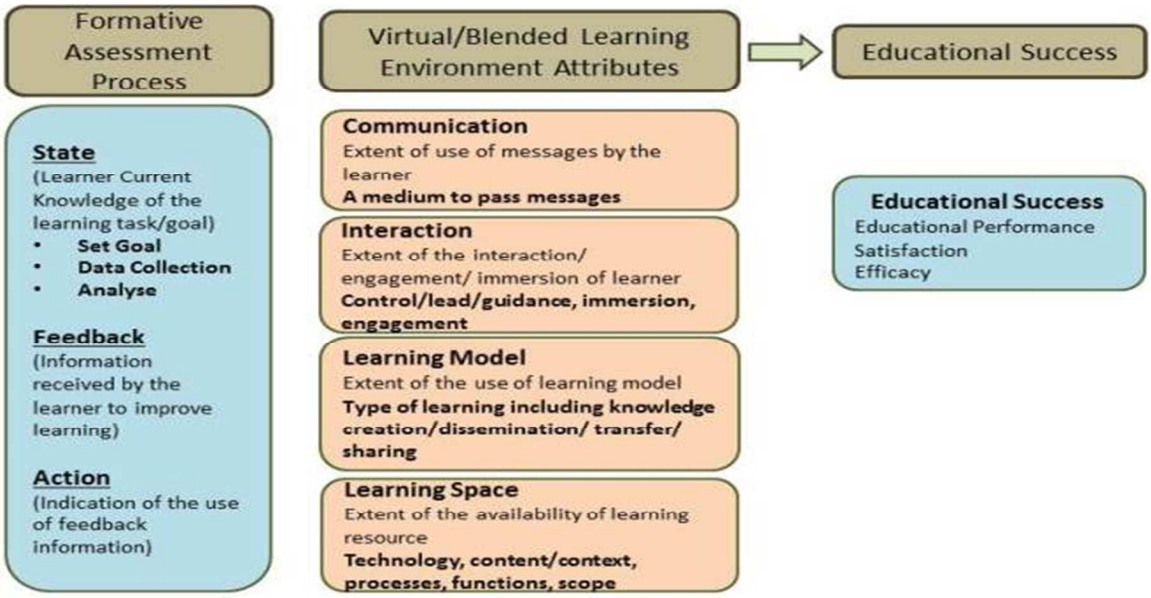

Figure 2: Framework for formative assessment in virtual learning environment (Developed Based on (Oxenford-O'Brian 2013; Piccoli et al. 2001))

Figure 2 presents our framework for formative assessment in a VLE, and focuses on the process and attributes of formative assessment. We now explore the formative assessment process for different types of formative assessment from the newly created attributes.

Research Development

The following section presents our findings from the analysis of formative assessment process by understanding the core functionality of formative assessment in VLE. Therefore, the attributes of a VLE relevant to formative assessment has been evaluated. We then explore the themes evolved from formative assessment and justify these themes with examples.

Attributes of Virtual Learning Environment in Formative Assessment

Formative assessment is a process that starts with setting a learning goal by the instructor and communicated to the learner (Black and Wiliam 1998; Oxenford-O'Brian 2013). Once the learning activity is started, data in relation to the learning goal will be collected. The data will then be analysed to assess the current state of the learner in relation to the learning goal. If there is a gap, the instructor will then advise learner how to fill the gap to achieve the learning goal. Information provided to the learner is the feedback which will be used by the learner to progress in learning. Consequently, it is viewed that the learning goal directs the formative assessment process. Learning goal can have a different purpose (goal to improve factual knowledge, goal to improve conceptual knowledge) and different levels (individual, group). Therefore it could be useful to investigate different types of formative assessment based on different goals. One such learning goal could be different types of knowledge improvements and another type is context dependent learning (Choi and Johnson 2005; Piccoli et al. 2001). First, the following table-2 presents formative assessment phases mapping with the descriptions of new attributes evolved from the literature.

Formative Assessment Phase	**Formative Assessment VLE Attributes**			
	Communication	**Interaction**	**Learning Model**	**Learning Space**
Establishing Learner State: (Setting goal, Collecting and analysing data)	Instructor and learner communicate for common understanding of the learning goal. Instructor formally/ informally discuss with learner to gather information	Instructor interact with learner to set learning goal. Instructor interact with learner to gather information	Objectivism: Instructor passes the learning goal information to the learner. Collaborativism: Instructor communicate with the learner to establish the learning state	e-Learning system, Course profile states the learning goal
Feedback: (Learner receives information to improve learning)	Feedback is provided to the learner by the instructor (similarly learner receives feedback from peers)	Learner receives general feedback through the e-learning system. Learner receives specific feedback through an email.	Collaborativism as learner and instructor shares the knowledge to develop learning. Constructivism, as learner develops the knowledge through the discussions	Learner is able to receive the feedback from the e-Learning system Learning material is needed and is available online
Action: (Learner	Learner reflects learning either by completing the task	Learner makes progress to the next level of	Learning model facilitate moving from one learning	Learner resources are available to reflect the progress of learning

progresses based on the feedback.)	or by moving on to the next learning activity	learning (by interacting with the learning system)	task to the next.	

Table-2: Formative assessment phases with VLE attributes

We have established new attributes as shown above in Table-1 and Table-2. We then extracted common themes evolved from the formative assessment process in VLE. These themes reflect different types of formative assessment. The next sections explain the formative assessment process and its relevance to proposed attributes based on the knowledge type, media based formative assessment, and the formative assessment based on the learning level.

Knowledge Type based Formative Assessment

Formative assessment in VLEs should be studied in the context of characteristics of virtual environments, information systems, and must consider the learning objective. There are different learning objectives based on different knowledge types. They are, factual, conceptual, procedural, and metacognitive knowledge (University of Illinois 2015). Computer based learning systems are effective in transferring factual and procedural knowledge by applying an objectivism learning model while conceptual knowledge can be developed by applying a constructivism learning model (Leidner and Jarvenpaa 1995). Virtual environments are good in communication, process integration, and knowledge development (Bitzer et al. 2013; Piccoli et al. 2001). To explain the applications of knowledge types in a formative assessment process, we use a hypothetical goal. A hypothetical learning goal is, "Learning how to use a management information system (MIS) consisting of MS-Excel to solve a business problem". In this situation we identify four different knowledge types, factual, conceptual, procedural, and metacognitive knowledge. Factual knowledge refers to the understanding the basic elements in the topic. For example, a learning task can be set to make sure that the learner understand the technical terminology such as Information Systems, MS-Excel, business case studies, and where to find the information about these terminologies. The Conceptual knowledge refers to the understanding the interrelationship between above explained factual terminologies/concepts. The Procedural knowledge refers to the understanding how to use information systems (MS Excel) in solving a business problem. The metacognitive knowledge refers to the understanding the general knowledge of the learning task as well as understanding the broader picture of the learning task as how it fits in a broader context (how MIS fits in business). Using this hypothetical case we present how the proposed VLE attributes map to the different types of knowledge (See Appendix-A).

Media based Formative Assessment

Media refers to the type of material used in learning such as text documents, audio files, and video files. It was found that different media influences learning differently (Choi and Johnson 2005). Objective of the formative assessment is to improve learning where different media can be helpful to improve learning as different individual learn differently. . For example, course profiles can be available online as a PDF or MS-Word document. But the lectures can be audio recorded (or even video) and made it available online for learners to be used at a later time in their preferred location. Learner will be able to get more realistic lecture experience having the lecturers recorded preferably as video files, and make them available online for learners. These files can be downloaded and used repeatedly, if the learner chose to do so. On the other hand there are different learning styles such as learning by listening and learning by observation. Accordingly we present a variety of different media in relation to the formative assessment process with our proposed attributes in a table format in Appendix-B.

Formative Assessment based on the Learning Level

Recent research shows the importance of the multi- level research for IS (Law 2012). Learning level in our research refers to the individual learner, group, and organizational levels. Detailed descriptions of learning levels are given in Table-3 below. Formative assessment requires active interaction between the learner and the instructor. Learner may interact with the systems and peers for learning and the instructor may need to interact with the learner, group, as well as the class. Such context requires that we investigate beyond the individual characteristics. A class must have group attributes rather than individual attributes. Accordingly, we believe that it is necessary to view formative assessment from the learner attributes, group attributes (communities of practice), and organizational attributes. However, once the data are collected at the individual level, they can be attributed to the individual, group, and organizational levels. Collective behaviour of individuals in a group can reflect the nature of the group. However the reverse attribution to lower levels is not possible.

Formative Assessment Level [Individual, group/class, organization]	**Formative Assessment VLE Attributes**			
	Communication (examples of communication activities)	**Interaction** (examples of interaction activities)	**Learning Model** (examples of applications of learning models)	**Learning Space** (examples of applications of learning space)
Individual	Communication between learner and instructor/ peer	Interaction between learner and instructor/ peer/ system	Objectivism/ Constructivism	Learning resources and functionalities available to the learner
Group	Communication between learner and peer in group or non-group work	Interaction between instructor and organization	Constructivism, Collaborativism	Discussion forums, Formal and informal Groups online
Organizational	Communication between instructor and organization. Eg: referring to policy documents about assessments	Interaction between instructor and organization. Eg: Resource allocation for teaching and learning	Objectivism. Collaborativism	Policies, facilities. Eg: Network and infrastructure facilities. Organization supported specific software and functions such as Blackboard software

Table-3: Formative assessment based on the leaning level

Based on the information in Tables in Appendix-A, Appendix-B, and Appendix-C the attributes identified communication, interaction, learning model, and learning spaces have significant relevance for feedback. However, without empirical evidence it is not possible to have a final conclusion. On the other hand development of measures for these three phases, namely state, feedback, and action may require different approaches. As explained earlier, formative assessment can be a formal or informal process where indications of activities not necessarily explicit. In addition, we must make a note that the feedback is viewed as the core function within the formative assessment process while establishing the state and the action are important to complete the process.

Validity and Reliability, Discussions, Contribution and Conclusion

Validity and Reliability

Literature review was instrumental in developing the initial attributes of the VLE for formative assessment process. Validity and reliability of our findings has been achieved by interviews continuing until no further findings evolve. Once the initial findings are recorded they were reviewed by research experts. Preliminary focus groups reviewed the literature review notes and then discussions continued to seek new information. Observations are recorded about the formative assessment and virtual learning environments. At the end, all data were cross checked for missing links, new themes, concepts, and attributes. Attributes evolved from the literature reviews, interviews, and focus groups confirmed the attributes identified.

The aim of the current research is to develop conceptual understanding of forms of formative assessment in VLE. This objective has been achieved from the analysis of the literature review and interviews. However further validation is suggested with the development of a measurement instrument that will allow quantitative evaluation of the effectiveness of various types of formative assessment. Analysis conducted for this research is viewed as qualitative and sufficient for literature review and conceptual framework development. Continuing research in this project is expected to refine the conceptual model consistently.

Discussion

Results, Analysis and Future Directions

Our findings confirm earlier research by developing similar themes and extend the direction of the information systems in VLE by emphasizing IS attributes. New attributes emphasises interaction, communication, technology savviness, and learning resources while accommodating learning models. These attributes has been accommodated in a consolidated set of new VLE attributes for formative assessment. Additionally, interviews suggested that the instructor to function as a facilitator than a driver in learning. Such approach could be useful when the learner is familiar and confident of the learning objective and the process. Also, during the initial phase of leaning, learning how to use the e-learning system can be challenging to the new learners who is beginning to use the system. Once the leaner is familiar with the e-learning systems, they have more positive acceptance of the learning system and also can influence the learners' technology efficacy as well as self-efficacy (Piccoli et al. 2001).

We find that there are different types of formative assessment. One of them is the formative assessment depending on the knowledge type where the learner needed to develop a specific knowledge type. We have explained knowledge type in formative assessment reflecting how each knowledge type could be mapped to the phases of formative assessment using four attributes found in this research (Appendix A). Other types explained are the formative assessment based on the media, and formative assessment based on the learning level (Appendix B, Appendix C).

There are other forms of formative assessment but cannot be included due to the space restrictions. Some of them are ontology based formative assessment, context based formative assessment, and driver/leader based formative assessment. Ontology based formative assessment considers the structural, dynamic, and social aspect of the formative assessment where static, dynamic, and social ontologies are applicable. Context based formative assessment considers situated learning and the learning environment the learner is in. Driver/ leader based formative assessment considers the process based on the trigger, ie., who initiated the formative assessment process. Usually the initiator could be instructor, learner, and stakeholder.

Learner attributes such human issues consisting frustration, motivation, and guidance must be recognized in a VLE. Our research focuses on the design dimension thus investigation of the human dimension is out of scope in our research.

Limited sample could limit generalization. Multiple pilot studies are in progress reflecting different type of learning and formative assessment in VLE. The research is expected to improve understanding of the formative assessment in VLE. However, educational institutions use blended learning environments where there is an impact from the traditional learning environments to VLE. The research must clearly note such situations when interpreting data. However, contemporary learning environments facilitate learner leading educational opportunities. The impact from traditional learning to online learning in a blended learning environment can be investigated in future research.

In summary, our research highlights IS attributes (eg: communication and interaction) and learning attributes (eg: learning model, learning space) are important for formative assessment in virtual learning environments. Further, our findings reflect the importance of different forms of formative assessment in a VLE.

Contribution

We have developed a working definition for formal assessment. We have identified the factors and characteristics involved in various different types of formative of assessment in VLE. We add our findings to develop a conceptual framework that explains the formative assessment process in Virtual learning environments. This theoretical contribution paves the way for the development of a quantitative instrument to measure the effectiveness of different types of formative assessment. Our contribution to practice is a taxonomy that allows educators and students to better understand the characteristics of different forms of formative assessment, and contribute to the likely effectiveness of each form.

Conclusion

Students wish to perform as well as they can in a learning environment. Formative assessment is a feature of learning environments that can assist students to perform better. Rapid changes in technology have meant more courses are being offered in a virtual environment, and little has been done to examine formative assessment contributions to student learning in design aspect of VLE. We investigated the characteristics of formative assessment and have developed a framework for formative assessment in a VLE design dimension. Our research is the first step towards a comprehensive quantitative study to examine the effectiveness of various forms of formative assessment.

Appendices

Appendix A - Knowledge Type based Formative Assessment

Formative Assessment Phase [factual, conceptual, procedural, meta-cognitive]	**Formative Assessment VLE Attributes**			
	Communication (examples of communication activities)	**Interaction** (examples of interaction activities)	**Learning Model** (examples of applications of learning models)	**Learning Space** (examples of applications of learning space)
Establishing Learner State: (Activities: Setting goal, Collecting data, and Analyse) Goal: Learning how to use MS Excel in solving a business problem. Data: Collected from instructor observations of learner activities or leaner's perceived view from a survey/interview. Analysis: Meta-analysis of the data can be done by the instructor or simple data analysis can be performed using MS Excel.	Learning goal is set by the instructor. Overall learning goal and sub-goals for each knowledge type is set and communicated to the learner. Instructor and learner communicate for shared understanding of the learning goal. Learning objectives are communicated to learners through the course profile in e-Learning site. Instructor discuss with learner to gather information of learning.	Instructor interacts with the learner to inform the learning goal through the e-learning system. Instructor interacts with the learner to gather information about the state of the learner knowledge. Learner and/or instructor interact with the e-learning system to refer to the learning goal, learning material, and other learning resources.	Objectivism: Instructor passes the learning goal information to the learner. Understanding of the factual knowledge is said to be performed best through the objectivism (Piccoli et al. 2001). Collaborativism: Learner collaborates with peers and the instructor to develop a MIS solution for a business problem. Such solutions are expected to be innovative where the knowledge is created by the learner.	Learning system improves access to resources, communication, collaboration,. Clearly identified different type of knowledge resources is available through the e-learning system which could include a statement, specific exercises to learners and data to the instructor.
Feedback: (Learner receives information to improve learning)	Feedback is communicated to the learner by the instructor. Feedback must be relevant to the learning objective. Feedback could be based on the overall learning objective or specific learning objective (factual, conceptual procedural, metacognitive knowledge). Overall learning objective	Feedback requires interaction between the learner and the instructor. Interaction with the learner or the class can vary based on the knowledge type or granularity of the feedback. Feedback provided to a student could be	Feedback requires collaboration such as, sharing email address and using the same e-Learning system where instructor can deliver feedback. Depending on the learning model such as objectivism or constructivism the type of learning can be improved. For example, objectivism model supports	e-Learning system, Instructor publish a general feedback for the learning task including the expected answers. Also, instructor can email specific feedback to the learner with comments for the learning

	based feedback can be communicated through e-learning systems while specific feedback could be communicated through email.	more explicit than the feedback provided to the class. Student may interact with the instructor and peers for feedback.	knowledge dissemination while constructivism supports knowledge creation.	activity. Accordingly, providing feedback require supportive functionality and processes from the e-learning system.
Action: (Learner makes progress based on the feedback.)	Learner reflects the knowledge of learning either by completing the task or by moving on to the next learning activity which is viewed as informal communication of the progress.	Learner makes progress to the next level of learning reflects learner interaction with the e-learning system.	Learner makes progress to the next level of learning is a reflection of learning. Such learning is valid for either objectivism or constructivism learning model.	Learning space provide an opportunity to show the progress of learning.

Table-4: Formative assessment based on Knowledge Type

Appendix B - Media based Formative Assessment

Formative Assessment Phase [Media Includes Text, Audio, Video]	**Formative Assessment VLE Attributes**			
	Communication (examples of communication activities)	**Interaction** (examples of interaction activities)	**Learning Model** (examples of applications of learning models)	**Learning Space** (examples of applications of learning space)
Establishing Learner State: (Activities: Setting goal, Collecting data, and Analyse) Goal: Learning to use MS-Excel in solving a business problem. Data: Collected from instructor observations of learner activities or leaner's perceived view from a survey/interview. Analysis: Analysis can be done by the instructor or can be performed using MS-Excel.	Learning goal/tasks is set by the instructor and communicated to the learner through text or video. Data collections are done by observations. Analysis is done through simple Excel work sheets or Meta-analysis of data. Charts and tables are used for analysis.	Learner interacts with the instructor/ system to understand the learning goal. Instructor interacts (eg: email, online class sessions) with the learner to gather information about the state of the learner. Data analysis is done for each media type.	Objectivism: Instructor disseminate learning information to the learner by text, video.	Having text and video certainly could improve understanding of learning objectives (Choi and Johnson 2005).
Feedback: (Learner receives information to improve learning)	Use of different media to communicate provide learner with choices to use preferred or most effective learning option	Feedback requires interaction between the learner and the instructor. Use of text (via email) and use online sessions increases feedback opportunities to learn.	Constructivism: Video conferencing is used as a different media in learning. Eg: Virtual classroom. Additionally chat (text) can be useful in forums, discussion boards.	Multiple media to improve learning.
Action: (Learner makes progress based on the feedback.)	Learner reflects the knowledge of learning either by completing the task or by moving on to the next learning activity (informal communication).	Learner interacts with the system when making an action to progress in learning. Learner interaction with the instructor to make sure the accuracy of learning.	If constructivism applied, moving onto the next level in learning is viewed as action. Objectivism model of learning may not indicate action directly.	Learner is provided with learning resources by using different media to reflect action.

Table-5: Formative assessment based on Media type

Appendix C - Formative Assessment based on the Learning Level

Formative Assessment Phase [Learning level: individual, group, organizational]	**Formative Assessment VLE Attributes**			
	Communication (examples of communication activities)	**Interaction** (examples of interaction activities)	**Learning Model** (examples of applications of learning models)	**Learning Space** (examples of applications of learning space)
Establishing Learner State: (Activities: Setting goal, Collecting data, and Analyse) Goal: Learning how to use MS-Excel in solving a business problem. Data: Collected from instructor observations of learner activities or leaner's perceived view from a survey/interview. Analysis: Can be performed using MS Excel.	Learning goal is set by the instructor and communicated to the learner through email or publishing in e-learning system. Learning objectives are communicated to the learners/ class/ organization through the course profile in e-Learning system. Data collection could be done by observations at the individual level. Analysis is done through simple Excel work sheets or Meta-analysis of data.	Learner interacts with the instructor/ system to understand the learning goal. Instructor interacts with the learner to gather information about the state of the learner knowledge. Individual level data can be attributed to class and organizational level. Data analysis is done for each level.	Objectivism: Instructor passes the learning goal information to the learner and to the class. Constructivism: The choice of constructivism type is based on the learning objective. However, class level and organizational level learning have limitations in applying the learning model. Communities of practice and organizational learning will be applied.	Learning system improves access to resources, communication, collaboration, and the formative assessment process. Findings at the individual level can be attributed to the higher levels where IS can be useful to develop abstract information including averages and median for class.
Feedback: (Learner/Group receives information to improve learning. Feedback to the class or organization are managed by the instructor)	Feedback is communicated to the learner by the instructor. Feedback provided to the learner can be specific or general while the feedback provided to the class or the organization is general. Communication with the class or the organization could be done communicating with the course coordinator or course director.	Feedback requires interaction between the learner and the instructor. Learner interact with the instructor as well as peers for feedback. Interaction with the class or organization is managed by the instructor and can have different behaviour.	Feedback must be able to develop learning. Objective of learning can vary so the feedback. Learning models objectivism and constructivism can be applied to the individual learning.	Resources are available to the individual learner through the e-learning system. Instructor can facilitate personalized feedback to the individual learner. The class/ organization feedback must be interpreted and applied by an individual.
Action: (Learner makes progress based on the feedback.)	Learner (or class) reflects the knowledge of learning either by	Learner interacts with the system when making an action to progress	Collaboration: Indication of action can be collected from the learner by	Individual learning can be supported with the guidance of

	completing the task or by moving on to the next learning activity which is viewed as communicating (informal) learner progress.	in learning. Class/ organization interaction is a collective interaction of the group of students.	questioning, survey, observations. However class/ organization action is a collective action of individuals. Learner level actions can be attributed to the class/ organizational level action.	the instructor but class or organizational level learning will be visible as policies, processes, and guidelines.

Table-6: Formative assessment based on Learning level

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