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Research in online learning environments: Priorities and methodologies

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ABSTRACT

Due to increasing demand for education and training in the information age, online learning and teaching is becoming a necessity in our future. However, lack of research goals to understand impact of online learning environments on students is a problem in research on online learning environments. We identified four main research goals to pursue in online learning environments based on their impact on learner achievement, engagement, and retention (opposite of attrition). Those goals are (a) enhancing learner engagement & collaboration, (b) promoting effective facilitation, (c) developing assessment techniques, and (d) designing faculty development programs. Current promising work in those areas is presented. Four methods that are common in the instructional technology literature are recommended to pursue those goals. Formative research and developmental research are relevant for all four. Although appropriate for any of the goals, experimental research is a better fit for goals b and c, and activity theory is useful for goals a and b.

1. Introduction

Why online learning environments (OLE)? One of the steps proposed in the National Education Technology Plan by the U.S. Department of Education (2004) focuses on supporting online learning and virtual schools. The fact that universities offering online courses are increasing everyday implies the need for proliferation of online learning environments (Bonk, 2002; Duffy & Kirkley, 2004). Professionals in business environments need to become lifelong learners to upgrade their skills and learn new business practices to survive in the competitive information age. The same is true for high schools, too. In some districts, virtual schools are becoming as important part of the system as the traditional schools (Molenda & Bichelmeyer, 2005). "Online learning is fast becoming a part of the norm" (U.S. Department of Education, 2007, p. 5).

Literature on online learning is abundant of comparisons of distance education to the traditional teaching and learning contexts (for example, Haugen, Ask, & Bjoerke, 2008). Research on online learning should go beyond comparing traditional learning and online learning environments. Consequently, there is a pressing need for further research on the components of online learning environments. The purpose of this paper is to identify student outcomes and research areas to design and develop effective online learning environments, and to match appropriate research methodologies for pursuing such outcomes.

2. Defining online learning environments

Gunawardena and McIsaac (2004) summarize *Distance Education* (DE) as one in which the teacher and learner are separated from each other and involve in a two-way interaction using technology to mediate the necessary communication. *Online Learning* is a type of delivery method used in distance education that allows the synchronous and asynchronous exchange of resources over a communication network (Khan, 1998). *Online Learning Environment* is also the system surrounding the learner and the teacher in terms of technical and social aspects (Khan, 2000b).

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3. Vision for future of online learning environments

From the systems standpoint, designing online learning environments involves a number of issues ranging from learner analysis to cost and to international perspectives (Moore & Anderson, 2003). A number of authors address directions for future research in online learning. Shearer (2003), for instance, synthesizes distance education into four aspects and directs instructional technologists for further research on each: learner autonomy, interaction, access, and cost effectiveness. Likewise, Gunawardena and McIsaac (2004) assert that "researchers should address issues of achievement, motivation, attrition, and control" (p.389).

Although all those projected issues have varying significances in terms of the effectiveness and efficiencies of online learning environments, following four research goals can be identified as the priorities for research in online learning environments:

1. Enhancing learner engagement & collaboration,
2. Promoting effective facilitation,
3. Developing assessment techniques,
4. Designing faculty development programs.

These four research areas closely affect *learner achievement*, *learner engagement*, and *learner retention*, which are the principal concerns of education and which can be studied as the outcomes, or dependent variables of the future research to improve effectiveness of online learning environments (see Fig. 1). Keeping all these issues in mind, this paper focuses on (a) the proposed research goals, and (b) the recommended research methodologies that are suitable to pursue these goals.

4. Proposed research agenda Goals

4.1. Goal 1: enhancing learner engagement & collaboration

Learner engagement is defined as the effort learners devote to activities that are focused on education. Many authors assert that learner engagement is a strong predictor of learner achievement and personal development (Astin, 1993; Baker, Spiezio, & Boland, 2004; Kuh, 2003; Pascarella & Terenzini, 1991). Moreover, learner retention (Spady, 1970; Tinto, 1975) and achievement (Cakir, 2006; Chaves, 2003) critically depend on learner engagement.

Certain educational practices lead to high student engagement (Chickering & Gamson, 1987). Among these, learner interaction in online learning environments has implications on learner engagement and collaboration. According to Anderson (2003) "engagement is developed through interaction" (p.129). He groups interaction under six categories including learner–learner and learner–instructor interaction. Interaction is also interpreted as dialog (Saba & Shearer, 1994). Based on Vygotsky's socio-cultural theory, Zhu (1998) states that "instruction is most effective when it is in the form of discussions or dialogues" (p.234).

Several authors associate online collaboration with improvement in volume and quality of student involvement, satisfaction, engagement, and higher-order learning (Hiltz, Coppola, Rotter, & Turoff, 2000; Khan, 2000a; Mikulecky, 1998; Oncu, 2007). Moreover, group discussions in online learning environments through collaborative involvement increase not only the productivity of the group but also individuals' ability to think critically (Angeli, Valanides, & Bonk, 2003; Garrison, Anderson, & Archer, 2001; Jeong, 2001). However, it is very uncommon to see fruitful discourse among online groups working collaboratively (Collett, Kanuka, Blanchette, & Goodale, 1999; Klemm & Snell, 1996).

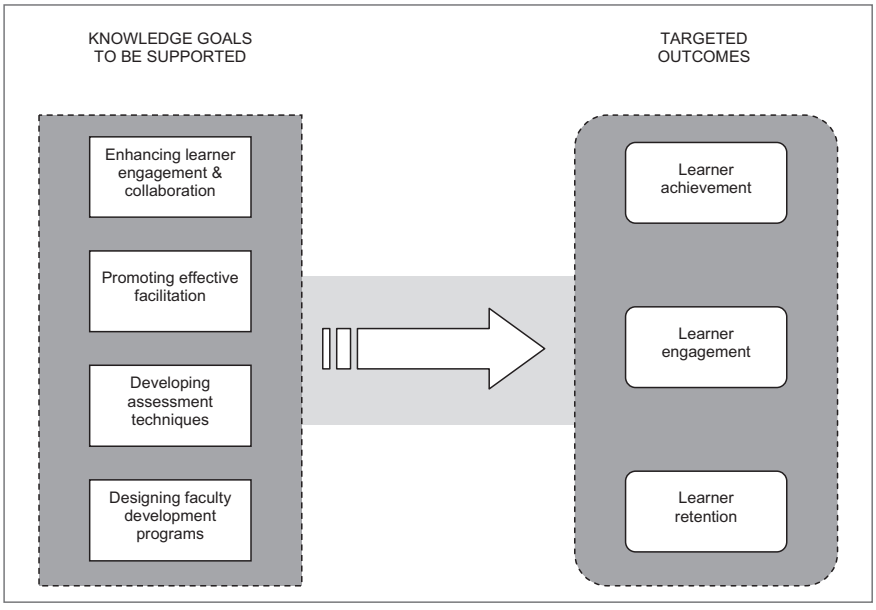

Fig. 1. The visual representation of the recommended knowledge goals in online learning environments and the outcomes they affect.

Currently, promising research are underway to investigate interaction and collaboration in relation to learner achievement, engagement, and retention in OLE, such as building online learning communities, and investigating levels of interactivity (Auyeung, 2004; Charalambos, Michalinos, & Chamberlain, 2004; Lock, 2002; Robinson & Hullinger, 2008; Santovec, 2004; Sims, 2003; Whymark, Callan, & Purnell, 2004).

Possible research questions investigating these qualities can include:

- What is the current level of learner engagement in current OLE?
- How can the learner engagement be measured?
- What are the strategies to eliminate passive learner engagement and promote contributive learner involvement in OLE?
- What specific learner roles, tasks, or patterns of collaboration enhance effective collaboration among online learners?
- What are the best practices on OLE about collaboration?
- What principles of course design and development processes promote learner engagement, interaction and collaboration?
- What is the proper amount of interaction in OLE in terms of relative expectations of learners and instructors vs. learner achievement?

4.2. Goal 2: promoting effective facilitation

Facilitation is another factor that can directly affect learners' engagement, achievement, and retention in online learning environments. How the facilitator treats the learners can change the way learners comprehend the learning environment and act correspondingly. Garrison, Anderson, and Archer (1999) present three kinds of presences that have implications for facilitation: cognitive presence, social presence, and teaching presence. *Cognitive presence* is "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Garrison et al., 1999, p. 89). *Social presence* is the degree to which a person comprehends another person as real. *Teaching presence* covers the design and integration of the social and cognitive presences into the learning environment.

While social presence is a point of consideration in facilitation (Rourke, Anderson, Garrison, & Archer, 2001), it is only necessary to a certain degree to support online learners (Wise, Chang, Duffy, & del Valle, 2004). Teaching presence manifests itself as social and cognitive presences. It is facilitating the cognitive presence, in particular, that has premises in improving those expected learner outcomes in connection with collaboration (del Valle et al., 2004). "Cognitive presence is a vital element in critical thinking, a process and outcome that is frequently presented as the ostensible goal of all higher education" (Garrison et al., 1999, p. 89).

Many examples of current research examine the impact of different facilitation techniques on various outcomes such as learning, critical thinking, engagement, and retention (Brahler, Quitadamo, & Johnson, 2002; Chiang & Fung, 2004; Collis, de Boer, & van der Veen, 2001; Garrison et al., 2001; Gilbert & Dabbagh, 2005; Hughes & Daykin, 2002; Lobel, Swedburg, & Neubauer, 2002; McLoughlin & Hollingworth, 2002; Mitchem et al., 2008).

Studying facilitation through fostering cognitive presence and the alternative methods of facilitating cognitive presence in online learning environments can provide knowledge to improve learner engagement, achievement, and retention. The following research questions can offer guidance for such research initiatives:

- What are the effective facilitation strategies that foster cognitive presence among online learners?
- What is the appropriate level of social and cognitive presence and how can this be integrated into the facilitation of OLE?
- How can the processes of designing and developing OLE that promote effective facilitation be improved?

4.3. Goal 3: developing assessment techniques

The purpose of assessment is to collect evidences to judge the quality of learning that occurs and to provide feedback to guide the learner throughout the learning process (Hyde, Clayton, & Booth, 2004). Assessment and feedback have potential impact to influence achievement and engagement if implemented correctly (Harlen & James, 1996; Porter & Brophy, 1988). Furthermore, Chickering and Gamson (1987) contend immediate feedback as one of the best practices in undergraduate education. In an environment where immediate instructor feedback is limited, the issue of assessment becomes more and more important. In online learning environments where the constructivist approaches to teaching expect learners to be self-directed and critical thinkers, it is important to provide assessment techniques that will guide and engage the learners (Macdonald, 2004). Newer and better ways of assessment and feedback techniques are becoming available to educators as technology progresses. Nonetheless, assessment in online learning environments is still an issue; a few studies focused on the role of assessment in online learning environments (Hyde et al., 2004). Most of the time the assessment is still text-based (O'Reilley & Patterson, 1998 in Hannafin, Oliver, Hill, Glazer, & Sharma, 2003). The amount of work done by the learner might deceivingly be preferred over the quality of work (Gunawardena, Lowe, & Anderson, 1997). Issues of reliability, validity as well as authenticity and security are still issues on OLE and are more problematic than the traditional learning in some aspects (Hyde et al., 2004; Rovai, 2000).

Many agree on the value of formative evaluation rather than summative evaluation in online learning environments. While maintaining efficient contact with learners is considered to be useful practice, it is found to be quite time-consuming. Sometimes parties other than instructors are involved in collecting evidences for assessment (Hyde et al., 2004).

It is not that there are not promising works in the topic of assessment in online learning environment. For example, Liu, Chen, Wang, and Lu (2002) report effective ways of utilizing portfolios to assess learners' "activity performance" in online learning environments. This approach also helps teachers to arrange their strategies in a desired direction. Macdonald (2004) reported practical implications for implementing successful online assessments based on different online research studies, such as providing assessment at critical points to create learning opportunities, providing assessment to offer learners incremental supports, and providing iterative, formative and peer feedback to enhance engagement. Dirks (1997) identified eight strategies ranging from discovering constraints to self-evaluation of the assessment strategies that can guide instructional technologists in designing and developing assessments for online learning environments.

In such a rapidly changing technological era, it is important for instructional technologists to keep up with the available technology and provide learners with more advanced ways of assessment and feedback. Research projects guided by the following sample research questions are worth to pursue:

- How can the instructor/peer response time be reduced to meet learners' expectations in online assessments (for example, how quickly the instructor and learner can respond to each other in asynchronous networks)?
- What methods improve reliability, validity, authenticity, and security of learner assessments in OLE?
- What techniques offer effective automated assessment and immediate feedback systems; and how can these be integrated into OLE?

4.4. Goal 4: building faculty development

Instructors have been one of the enduring components of instructional systems. This is true for OLE, too. Instructors' manipulation of OLE is a factor that affects the achievement, engagement, and retention of learners (Scalese, 2001); for example, the value of facilitation, through which an instructor projects his presences, has been discussed earlier. As Garrison (2007) indicates, "educational challenges raise the importance and role of teaching presence" (p. 69). Most faculty currently teaching in traditional settings have challenges to teach online (Bower, 2001; Ellis, 2000; Perreault, Waldman, Alexander, & Zhao, 2002). Faculty candidates who are likely to teach online in the future need acquaintance with online teaching and learning methods. More importantly, for instructors to be competent with all of the issues identified earlier in this paper, it is imperative to provide them with strong professional development opportunities. Hiltz, Kim, and Shea (2007) find lack of adequate support to be one of the major reasons for faculty dissatisfaction in online teaching.

Rewards and incentives are a way of supporting faculty. However, findings of this research have not been enough to provide necessary guidance for faculty teaching in online learning environments (Lee, 2002), and studying them does not seem a priority anymore. Identification and dissemination of the best practices of the faculty is a useful strategy.

There are promising studies that encourage improvement in the area of faculty development in online learning environments. Howell, Saba, Lindsay, and Williams (2004) identify seven strategies to improve faculty development (see Table 1). Fredericksen, Pickett, Shea, Pelz, and Swan (2000) reported a study in which instructional designers developed a faculty support system based on research data. They identified a four-stage faculty development process, as well as a seven-stage course design process with high faculty satisfaction.

Despite these works, there is much to be accomplished given the influential extent of faculty development for online learning environments. Research studies to pursue this goal can be guided by the following questions:

- What are the effective processes for designing and developing operational faculty development programs to be embedded into online learning environments?
- What are the best practices of faculty to engage and retain learners in online learning environments?
- How can the best practices of faculty in online learning environments be made available and disseminated effectively for the use of others?

5. Methods

All these research areas have implications for instructional technologists from two perspectives. *First*, all these research areas ask for improving the design and development of online learning environments, which has implications for *instructional design theories* and *instructional systems development* process (Reigeluth, 1999). Such a task requires methods that are appropriate for designing and developing instructional systems. The first two methods, *formative research* and *developmental research*, that are recommended below meet this requirement. *Second*, the nature of the studies proposed above requires instructional technologists to compare and deeply analyze the effects of certain treatments for the design and development considerations in addition to investigating the nature of relationships among online learners, faculty, and their environment. The last two methods, *experimental research* and *activity theory*, respectively, are recommended in response to those needs. It should not be forgotten that all these methods are suitable in any of the proposed agenda items.

It could also be useful to visualize and operationalize the methodologies progressively rather than marginalizing one methodology to any one specific goal. Fig. 2 depicts this physiology. In this perspective, all the proposed methods below could be used to address every goal *at some point*. Research is an ongoing process. Certain methods can be applied early in the process such as the activity theory to less empirically explore the relationships among elements of the examined context and activity. Following that, methods emphasizing the design and development of settings, and therefore, aiming to improve instructional design would come forward. Then, the experimental designs play their role to test the relationships in the newly developed settings. And, this cycle would continue as necessary. To repeat what is said in the above paragraph, any one methodology is not necessarily better suited to any one goal than another.

Another important point in studying online learning environments is the nature of the data. Since most interaction is in text, audio, or video format, qualitative data analysis techniques such as *discourse analysis* (Gee, Michaels, & O'Connor, 1992) and *content analysis* are

Table 1
Strategies for improving faculty development in online learning environments – adapted from Howell et al. 2004.

Enable colleges and departments to accept more responsibility for distance education activities;
Provide faculty with more information about distance education programs and activities;
Encourage faculty to incorporate technology into their traditional classrooms;
Provide strong incentives for faculty to participate in distance education;
Improve training and instructional support for distance education faculty;
Build a stronger distance education faculty community;
Encourage more distance education scholarship and research.

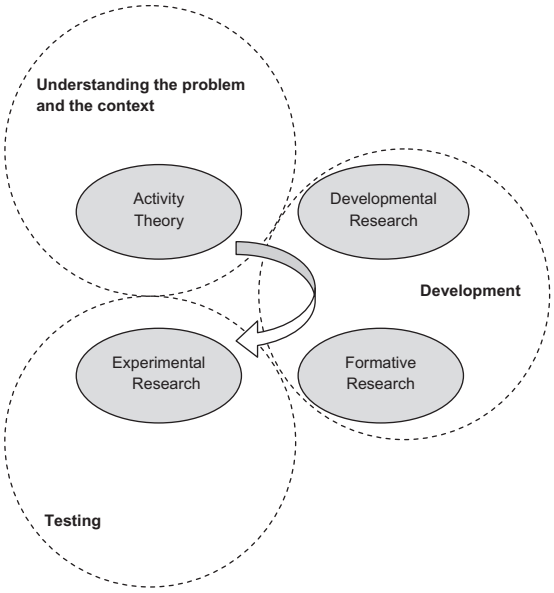

Fig. 2. Conceptualizing the proposed research methodologies as an ongoing process.

usually necessary (Ryan & Bernard, 2000). The methods given below already utilize qualitative data analysis techniques. In some cases, such as experimental studies, quantification of the data may become necessary.

It is important to note that the methodologies that are recommended here are not newborn to the field, and it is not the intent of this paper to introduce them as such. These have been available and used in the instructional technology literature for some time. The purpose of this section is to link those methodologies to the goals that have been identified in this paper in terms of how to better pursue those goals.

5.1. Formative research

Majority of research in education aims to generate descriptive knowledge in education, in other words to describe an existing situation to be able to explain and make predictions about future. On the other hand, designing learning environments requires reliable and valid design theories and/or guidelines to create meaningful and efficient learning environments. In the history of education, formative research was initially considered and used as a methodology to improve instructional products and curricula. In their study, Reigeluth and Frick (1999) extended the utilization of formative research to create new or to improve existing instructional design theories or models. They described three major purposes of formative research; (1) to improve instructional products and curriculum, (2) to improve existing instructional design theories and models, and (3) to improve existing instructional systems development theories.

Formative research methodology has its own path to follow. Reigeluth and Frick (1999) claim that conducting a formative research requires to be familiar with the qualitative research techniques and jargon. They provide a general guideline to conduct formative research. Since the aim of the formative research is to improve design theories, first step is either to select an existing instructional design theory or to create a new instructional design theory. Second, by applying this theory or model, researchers need to develop an instructional situation. The main aim is to unearth the strengths and weaknesses of the theory by utilizing the design theory or model as it is prescribed. During the utilization of the theory in design activity, the researchers need to collect data about “what worked” and “what did not”. Typical data collection tools are open-ended and structured interviews, focus group meetings, think-aloud procedures, and surveys. Finally, based on the findings from the data, researchers revise and improve the instructional design theory for a better application to future use. It is better to apply the theory in different design situations to increase the generalizability of the theory in other design cases; therefore formative research and revision cycles should be repeated several times to improve a theory or model.

Formative research has similar methodological issues that one can find in any other research studies. Reigeluth and Frick (1999) categorize them as construct validity, thorough data collection, credibility, and generalizability issues. First, construct validity refers to whether the design theory is on target, in other words it encompasses all the elements to design the intended instruction. It can be established through receiving expert opinions and thorough review of the literature and the model. Second, during the data collection process, participants should be prepared prior to the interview with the researchers and researchers should use grounded theory approach to allow the weaknesses of the theory to emerge. Third, credibility of the findings should be established through using multiple data sources, cross validation, and member checking. Finally, replicating the formative research for a theory or model with multiple and different instructional design situations will increase the generalizability of the theory in different design cases.

Although formative research methodology is a better fit for designing learning environment process, it has strengths and weaknesses in comparison to other research methodologies. It is out of this paper’s aim and scope to discuss them in detail; however it is useful to mention few of them. The strength of the formative research comes from its goal. Since formative research is an activity to generate prescriptive knowledge through improving design theories and models, it guides instructional designers and theorists to avoid pitfalls during the application of a particular theory/model in a design activity. The weakness of the methodology comes from its nature; repetition of the formative research using the same theory or model is necessary to establish the validity and generalizability of the studied theory or model. It is a collective research effort and if no other researchers continue to study that theory or model, it will be difficult to establish the validity and generalizability of the theory in the future.

As stated at the beginning of this section, formative research is a way to create and improve instructional design theories (Reigeluth & Frick, 1999). All of the recommendations given in Goals 1 through 4 of the proposed research agenda have the underlying expectation to improve the methods of teaching and learning activities in online learning environments. Instructional technologists should be interested in improving instructional design theories and models to enhance learner engagement and collaboration in online learning environments. Formative research, therefore, is a viable choice to implement all the proposed agenda items and is the first recommended methodology to apply. Formative research is especially a necessary methodology for the Goal 3 in the proposed research agenda: developing assessment methods in the online learning environments.

In order to develop reliable, valid, and generalizable student assessment methods using formative research in online learning, one has to start with either developing a method or select from available evaluation methods that have room for improvement. For example, the biggest challenge in evaluation of student learning in online learning is to measure the quality of student postings in class interactions (Anderson, Rourke, Garrison, & Archer, 2001; Rourke & Anderson, 2004). A method or a model is needed to systematically assess the quality of students' postings, which will assure the objective evaluation of the students. By reviewing the available literature and existing studies, researcher(s) can develop an evaluation model or select an already developed evaluation model. In order to assure the initial validity steps, the researchers discuss the model with experts from the field and revise it as necessary. Then following this model, researcher(s) design and develop a tool to measure the quality of student postings during the discussions in online classes. At the same time, they collect data through interviews, recordings or document reviews to understand the problems related to the application of this newly developed student evaluation model. Analysis of collected data will show researchers about the weaknesses of the model and the revised version for future applications will be developed. Repeating the study for other situations will improve the generalizability of the model in other design situations.

5.2. Developmental research

The dictionary definition of development means "gradual growth of a phenomenon" and it has been frequently used in the field of child psychology. The same term is used in the field of instructional design with a unique meaning. Seels and Richey (1994) define development phase of instructional design as "the process of translating the design specifications into physical forms" (p. 34). A prescriptive theory, model, or a guideline is always needed to design and develop instruction or instructional systems, therefore, similar to formative research, developmental research can be utilized to improve instructional design theories. In addition to that, developmental research also aims to improve the processes of design and development through studying these phases of instructional design process (Reeves, 2000; Richey, Klein, & Nelson, 2004). Richey et al. (2004) distinguish a type of developmental research from formative research in that formative research produces solutions for specific cases whereas developmental research usually aims at generating generalizable design process principles. While the role of instructional technologists is to develop the methods of instruction or processes of instructional development, it is also important that they apply and refine these principles/processes through developmental research and, therefore, contribute to the field.

After extensive review of available studies in the literature, Richey et al. (2004) summarize types of conclusions that can be drawn from developmental research studies, which gives an idea about what to expect from developmental research studies. The list includes following types of knowledge produced by developmental research: (1) Validity and/or effectiveness of a design technique or instructional design model, (2) Critical success factors to implement an instructional model or process, (3) What worked and what did not during the implementation of an instructional model or process, and (4) Generating a new model/process and/or improve an existing instructional model/process.

Data collection methods and methodological concerns that exist in formative research take place in the development research as well. A researcher should be familiar with and have the experience related to the fundamental research concepts, qualitative data collection and data analysis. Expert reviews, document analyses, focus groups, and surveys are frequently employed methods in the developmental research. The application of a developmental research resembles the application of a formative research. It starts with selecting or developing an instructional developmental model or theory. Then it requires developing an instructional process by using this particular model. At the end of a developmental research activity, the theory, model or process that was under investigation is revised to improve the future applications.

As in any educational research, developmental research also has some strengths and limitations during the application. On the strengths side, developmental research generates knowledge that provides pathway or guidelines for other instructional designers for successful implementation of a particular development model. It helps others to avoid pitfalls of the process and maximize the efficiency while developing instruction. However, on the limitation side, it takes more time and effort in comparison to the descriptive research efforts. Establishing the validity and credibility is a major concern for developmental research. During the developmental research, most of the time application of a development process and collecting the data related to this particular process go hand in hand, which increases the load of researcher or the number of researchers in a developmental research project.

Although all of the research agenda goals for online learning environments presented in this paper can utilize the developmental research method, particularly the goal 4, building faculty development, can benefit the most from developmental research methodology. With the introduction of hypertext/hypermedia and online learning environments, designing and developing programs that help faculty to use these learning environments effectively have become necessary (Hiltz et al., 2007). Very few models for developing successful faculty development are available in the literature. Using the developmental research methodologies, models that are generalizable to most situations or models that are specific to certain situations can be developed or improved.

5.3. Experimental research

Experimental research is conducted in order to identify or test a relationship between variables. In experimental studies, researchers attempt to manipulate a variable and observe cause-and-effect relationships (Fraenkel & Wallen, 2000; Krathwohl, 1998). Therefore causality lies at the heart of experimental research (Cohen, Manion, & Morrison, 2000). Knowing that something causes something else to happen helps predict what happens if similar conditions are met in similar conditions. Cohen et al. (2000) state that a clear causality can be obtained by removing other competing causes, after which a model tested by the research study can explain the results more clearly. For

some researchers this may be the only way to conduct a healthy research study, but Cohen et al. (2000) also argue that such philosophy is rather questionable because competing causes can never be completely eliminated.

In experimental research, the manipulated variable is called the independent variable, and observed variable is called the dependent variable. The experimental research is usually depicted by simple drawing models with a timeline, called *designs*. In such models, the independent variable(s) are symbolized with *X*s and observation of the dependent variables is depicted with Os. Some models have the symbol of R, representing the random assignment of the subjects to the research groups.

There are several experimental research designs. Table 2 is a list of the major experimental designs. The first and the simplest way of experimentation, in Fraenkel & Wallen's terms, is called "one shot case study design". In such designs, a group is subjected to an experiment, and only the results are observed (unlike some other settings where the beginning conditions are also observed).

The one-group pretest–posttest design (on the second column of Table 2) differs from the first one in that the subjects are observed also before the experiment. This way the researcher can compare the difference between the first and the second observation.

Experiments usually involve comparison of two or more groups. When a group is introduced to the design, one of the groups is called the control group, and the other groups are called the experimental groups. Usually no treatment is applied to the subjects that are in the control group. Therefore the treatment's direct effect on the experimental group is tested. Sometimes the control group is also given a treatment that is different from the one given to the experimental group(s).

The static group designs in Table 2 (third and fourth rows) have one addition to the above designs (the first two rows); that is the introduction of the *control group*. The convention of X_1 and X_2 is used to show two different treatments. The static group experiments are conducted on already existing groups.

So far the designs have been incrementally introduced; that is a new group or observation was added to each new design. The next addition is the *randomization*. The randomization means the subjects are randomly distributed to the groups. The randomized posttest-only control group design and the randomized pretest–posttest control group design are the randomized forms of the static group designs. The randomized Solomon four-group design is a combination of the previous randomized designs. The purpose of the combination is to create a design that is as close to the real life conditions as possible. There are many other ways to randomize the groups (Fraenkel & Wallen, 2000) but explaining those would go beyond the scope of this study.

When an experiment is conducted on already existing groups, it is called *quasi-experimental* design. The first four models on the table could also be described with this definition. They were given in the table to better compare to and explain the other true experimental design models. Quasi-experimental designs do not employ random assignment techniques. There are several quasi-experimental designs other than the ones given in the Table 2. This section focused on the true experimental designs as they are more preferable than the quasi-experimental designs to overcome some threats that are given in the section below.

One other convention used in experimental research is the principle of *matching*. Matching requires subjects to be equalized on one or more variables to obtain more balanced experimental groups. Mechanical (robust one by one matching of subjects on certain characteristics) and statistical (by predicting and forming groups on certain statistical characteristics) matching exists. This principle can be used to extend the power of experiments.

Some threats that are more specific to experimental designs exist, called validity issues. There are two things to care in experimental research design: internal validity and external validity. Internal validity refers to the structural integrity of the research design. External validity refers to the generalizability of findings to other, broader settings.

Internal validity is concerned with the relationships between the variables that are examined in experimental studies and asks whether such relationships are properly crafted (Shadish, Cook, & Campbell, 2002). An experimental research may result in altering a setting other than the intended one and such an experiment would not be internally valid (Leedy, 1997). To be more specific, an experiment is not internally valid…

- if factors other than the treatment affect (confound) the outcome variable (confounding variable effect),
- if the subjects were not randomly selected and distributed to experimental groups (selection bias),
- if external events make harder to draw a relationship between the targeted variables (history effect),
- if time required for the study inevitably alters other factors, making it questionable to attribute the changes in outcome variable to the treatment (maturation effect),
- if the participants are tested repeatedly so much or frequent that they remember the answers they gave in a previous test (testing effect),
- if the initial instrument changes during the experiment (instrument change),

Table 2
Major experimental research designs.

Fraenkel & Wallen	Cohen et al.	Design[a]				
The one shot case study design					*X*	O
The one-group pretest–posttest design	A pre-experimental design: the one-group pretest–posttest			O	*X*	O
The static group comparison design		*E*			X_1	O
		C			X_2	O
The static group pretest–posttest design		*E*		O	X_1	O
		C		O	X_2	O
The randomized posttest-only control group design		*E*	R		X_1	O
		C	R		X_2	O
The randomized pretest–posttest control group design	A 'true' experimental design: the pretest–posttest control group	*E*	R	O	X_1	O
		C	R	O	X_2	O
The randomized Solomon four-group design		*E*	R	O	X_1	O
		C	R	O	X_2	O
		E	R		X_1	O
		C	R		X_2	O

[a] *E* = Experimental group; *C* = Control group; R = Random distribution of the subjects; *X* = treatment; O = Observation.

- if outliers are used who could potentially behave normal (or close to the mean scores) in another testing and potentially cause a random error (random error effect or regression toward the mean)
- if participants drop out during the study and those that drop out could potentially alter the results (mortality),
- if the treatment leaks to the control group, so that the subjects in that group get aware of what is being altered in the experiment (diffusion),
- if the control or the treatment group subjects are psychologically affected by the experiment (compensatory rivalry), or
- if the experimenter unintentionally behaves differently to the groups of the study (experimenter bias).

External validity, on the other hand, is concerned with the extent of the findings – obtained from a sample – to the other wider settings and is also known as *generalizability*. It asks whether the findings are representative of the population, and of the other contexts and experimental settings (Leedy, 1997). If the findings cannot be generalized, the research design is not externally valid.

Fraenkel and Wallen (2000) envision two types of external validity: population generalizability and ecological generalizability. These are related with the sample, the selection process, and the settings in which the experiment is conducted. Cohen et al. (2000) extend this definition to four areas. An experiment is not externally valid…

- if the constructs utilized in the research apply only to a certain group or sample (selection effect),
- if the findings obtained from the research are mostly only representative of the context of the experiment and would not be observed elsewhere (setting effect),
- if the findings are a function of other external events rather than what is manipulated in the research and therefore cannot be generalized to other settings (history effect), or
- if the utilized constructs reflect the characteristics of a certain group (construct effect).

Issues to validity can be avoided. Fraenkel and Wallen (2000) offer four solutions to avoid internal validity issues: (1) standardizing the conditions in which the experiment is conducted to control important aspects of the experiment such as the subject attitudes, (2) obtaining and using as much relevant information about the subjects as possible, (3) recording and using as much data about the logistics and details of the study as possible, and (4) selecting a suitable design for the experimental conditions. The last solution offers the most benefit to the internal validity issues.

In order to avoid issues to generalizability (external validity), researchers should seek ways to obtain representative samples. This involves caring for the characteristics of the subjects being studied so that they represent the population and also involves randomization of the selection process. The researchers should be careful in interpreting the results, as well, because any over-interpretation would also be a threat to external validity especially in terms of ecological validity (Fraenkel & Wallen, 2000).

As mentioned previously, when these issues are taken care of, the experimental study is one of the most powerful research techniques to determine cause-and-affect relationships. In this perspective, it could be considered the most scientific research methodology. Therefore, instructional technologists can use experimental methodology to compare two or more groups based on the manipulation of a (independent) variable and observe its effects on the dependent variables – just like the variables defined at the beginning of this paper: achievement, engagement, and retention. It would be particularly useful to incorporate experimental research on testing and improving the methods of facilitation (goal 2) and assessment (goal 3) because these goals are particularly keener to the empirical manipulation and testing, and finding relations between the successful techniques and student success, participation and retention. Experimental research can also be relatively more useful in studying engagement and collaboration, rather than guiding faculty development. Faculty development is a concept that possibly involves several confounding factors and long-lasting timeline, both of which can risk the validity of experimental designs.

5.4. Activity theory

Activity theory (Engestrom, 1987) establishes a framework to describe how people, individually or as a group, participate in an activity. Activity theory is "a theoretical and methodological lens for characterizing, analyzing, and designing for the participatory unit" (Barab, Evans, & Baek, 2004, p.199). It gives the opportunity to do an in-depth analysis of the tools people use, the relationships among people participating in an activity, and the purpose and consequences of that activity. Activity theory is used for several purposes. According to Christine (2002) people use activity theory to identify cooperation among people and many studies examine computers' role in this cooperation through activity theory. Christine (2002) also gives examples of software development processes and information design processes studied through activity theory. According to Kaptelinin and Nardi (2006) activity theory can inform design decisions and help evaluate products in the fields of human computer interaction and cognitive science. In general, activity theory is used to develop models that broaden existing theories (e.g., Clases & Wehner, 2002) or it is used to examine new, case based contexts (e.g., Nardi, Whittaker, & Schwarz, 2002).

In activity theory, everything is centered over the activity. The elements of the theory are visualized around an activity triangle model (see Fig. 3). Mwanza (2001) summarizes these elements in an organized fashion. In Fig. 3, the *subjects* are the individual or the group of people participating in the activity. The *tools* are the concrete or abstract items that are used by the subjects toward a specific goal. "The most basic relations entail a subject (individual or group) oriented to transform some object (outward goal, concrete purpose, or objectified motive) using a cultural–historically constructed tool (material or psychological)" (Barab et al., 2004, p. 203). The *object*, then, why people do an activity – the goal and the purpose the subject has.

Besides this basic relations triangle, some other, more complex elements are put into consideration in the activity theory. When an activity is done, a result or a product is obtained. The reason to do an activity is also considered a result. In the activity triangle, this is called the *outcome*. There can be multiple outcomes and they may be intentional or unintentional (Barab et al., 2004). The *rules* are the official or spoken regulations the subject is bound to operate in. Norms are another form of rules and – combined with the other kinds of rules – they influence whether and how the activity is achieved. The *community* is the social environment among whom the subjects perform their activity. People who work closely with the subjects affect the subjects' activities, deliberately or not. Finally, the *division of labor* is about how the workload is shared in the organization.

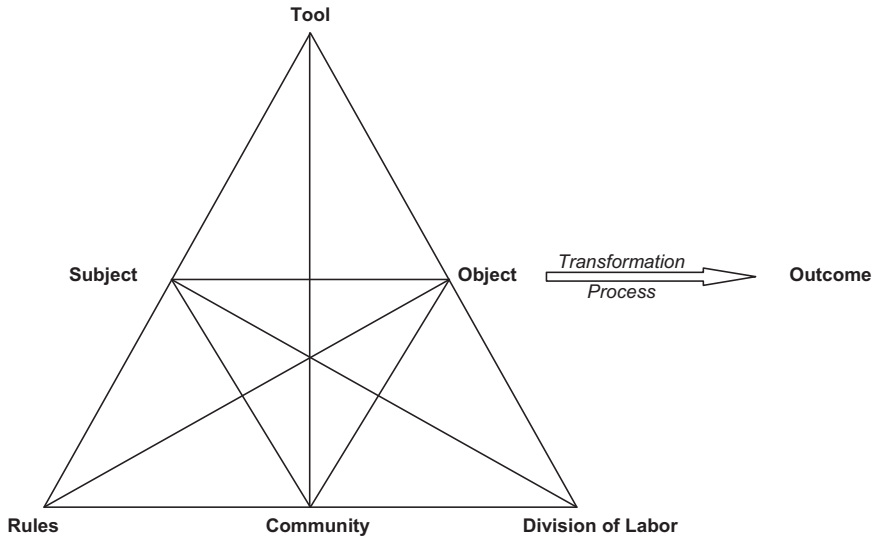

Fig. 3. Activity triangle model (Engestrom, 1987).

According to Christine (2002) during an analysis through the activity theory, stakeholders that are representatives of related parts of an organization and the processes that involve them are bore in mind. Activities are divided down into minor activities. And the context is studied through the several smaller triangles that make up the larger activity triangle model as seen in Fig. 3 so that the actions of the subject in achieving an object are scrutinized.

Christine (2002) indicates that strength of activity theory comes at the labeling of the artifacts. The labeling directs researchers' attention to the specific elements in the study and therefore provides better focus. The labeling also eases communication with other researchers who are exercising research with activity theory. Collins, Shukla, and Redmiles (2002), after completing a research study with the help of activity theory, summarize some values and challenges found in the activity theory. Collins et al., (2002) concurring with Christine's labeling point, indicate that activity theory helps achieve efficiency and quality in the research by helping directly transfer the data into the artifacts and relationships in the model. Moreover, they state that the given artifacts and the relationships are enough to explain the major aspects of the activity under investigation. From another perspective, the artifacts in the model also contribute finding the missing or inadequate elements in the study.

Although labeling as explained above provides advantages, it is also a challenge in that the terminology is sometimes confused with other common terminologies (for example object of activity theory is confused with objective that is often used in educational and business settings). Moreover, the nature of the activity theory helps interpret complex interrelationships via an arrowed diagram, which at times becomes hard to grasp by stakeholders as it is difficult to express the findings in simpler, less complex ways. Also, the theory is easy for researchers to study a setting but it may sometimes be hard to communicate the theory to the stakeholders. This may require researchers to use concrete examples to explain the findings or to state findings in the way that is accustomed in the organization where the study is conducted, by the help of an employee or so.

If learners and facilitators are considered as being a part of an activity, instructional technologists can consequently study the online settings and design. Activity theory is especially relevant to studying facilitation (goal 2), and learner engagement and collaboration (goal 1) because the primary components of these two items are the interaction and relationships between the actors.

6. Conclusion

Online learning environments have a promising future for researchers, practitioners, and learners. However designing and developing more effective and efficient online learning environments is possible with ongoing research and development. This paper offers four research goals and matches four existing methodologies to improve student outcomes in online learning environments defined as learner achievement, engagement, and retention. Learner engagement and collaboration is necessary to improve student satisfaction in online courses. Due to the format of the online learning environments, developing reliable and valid student assessment techniques for online learning environments is crucial to measure student achievement and student engagement. Finally, instructors in online learning environments perform different learning activities than they do in traditional (face-to-face) learning environments. It is imperative to prepare faculty development programs for teaching online learning environments.

In order to achieve these research goals, formative research, developmental research, experimental research, and activity theory methodologies are recommended. While formative research and developmental research methodologies are mainly appropriate to improve the quality of designed courses, experimental studies are useful to compare the effects of different teaching methods that impact student outcomes.

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