Simulation Design and Educational Practices: Inputs towards Dental Simulation Effectiveness

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ABSTRACT

Simulation is a part of dental education prior to treating patients. Ideally, dental clinicians should be confident enough to perform procedures on patients after finishing pre-clinical level through simulation. This study identified the gaps in teaching and learning process in-between patient simulation and clinical dentistry at EAC School of Dentistry by examining the (1) extent of implementing simulation design (2) extent of educational practices used in simulation and (3) effects of simulation to learning satisfaction and confidence as perceived by students. Relationships of variables were tested, and an inquiry was done to highlight the strengths and weaknesses of patient simulation. Questionnaires were adopted from the National League of Nursing with minor modifications. These included Simulation Design Scale (alpha: 0.92), Educational Practices Questionnaire (alpha: 0.91), Student Satisfaction (alpha: 0.94) and Self-Confidence in Learning (alpha: 0.87). After satisfaction of institutional and ethical requirements, 52 students were surveyed. Focus group discussion with selected students and faculty members was also done to obtain in—depth insights regarding learning and teaching of preclinical subjects through simulation. Data obtained were analysed using descriptive and inferential statistics. EAC dentistry students considered dental simulation highly effective in all phases. They experienced and expected high extent of simulation design requirements and simulation educational practices but emphasis on support, realism, and collaboration was highly encouraged. Generally, EAC dental students expressed increased self-confidence, satisfaction and learning through simulation.

Keywords: dentistry students, dental simulation, educational practices, simulation design, learning satisfaction

INTRODUCTION

Dental schools train students to become competent dentist in the future. Competency in dental education is based on two standards of learning: the content outcomes which is based on concepts and principles and performance outcomes which is based on skills. The integration of knowledge and skills is evident in the dental proper curriculum. Developing knowledge involves the incorporation of medical and dental subjects. Developing psychomotor skills starts at pre-clinical laboratory courses in a simulation-based environment in preparation for clinical setting. In dentistry, development of psychomotor skills is essentially a requirement to be a competent clinician. Simulation is an integral part of dental education. Ideally, dental clinicians acquire adequate competence and confidence to perform dental procedures on actual patients after the accomplishment of the course requirements on the pre-clinical level through patient simulation. However, some students are having difficulty during transition from pre-clinical to clinical dentistry. This leads to lack of confidence when treating actual patients, even if they have performed the procedures using simulation. This further leads to delay in finishing their clinical requirements which are pre-requisite to graduation. Simulation is the imitation of the operation of a real-world process or system overtime (Tavkar & Pawar, 2017).

Simulation is defined as an experiential learning that allows students to experience situations mimicking real-life situations in a controlled and safe environment (Badiee & Kaufmann, 2015). Simulation-based education is a good pedagogy if well-developed, well-implemented, and well-evaluated (Zitzelsberger 2015). Healthcare simulation duplicates certain characteristics of clinical reality that is dependent on experiential learning (Aggarwal et al. 2010). Effective simulation provides the learner to get involve in the simulated training components to develop skills and confidence that will be translated into clinical practice. Since simulation is a model of reality Badiee & Kaufman, (2015) pointed out that it can be called an experiential learning when it can echo the actual scenario. Thus, learner would be able to apply this learning to real-life situations. The use of clinical simulation in healthcare education is based on patient safety (Aggarwal et al. 2010). Features of simulation design are: objective and information, support, problem solving, feedback, and fidelity (Jeffries 2013). Identification of the learner, the method of learning, learning objectives and the learning outcomes are some of components to incorporate in the planning of simulation learning appropriate for the needs of the learner. Simulation has its strength as an educational tool, it can be concluded that simulation-based education is a good pedagogy if it is well-developed, well- implemented and well-evaluated (Zitzelsberger 2015). The use of simulation is to apply knowledge learned in the classroom to simulated environment and to transfer the skills into real-world practice and not merely facts and concepts (Roy et al. 2017). Simulation-based learning can also enable the formation of clinical reasoning (Cant & Cooper, 2010; Lapkin et al. 2010; Koivisto et al. 2017). Motivation in self-directed learning is necessary to be a success and may come from technical support, peers, and faculty. Faculty has a responsibility on giving continuous feedback to students after a simulation activity (Motola et al. 2013).

Fidelity is how realistic and accurate simulation is (Lateef 2010). Levels of fidelity are low, medium and high fidelity (Seropian et al. 2004). Simulation also needs to include unexpected situations, uncommon scenarios, and clinical cases that students may encounter in real-life clinical practice (Lateef 2010; Motola et al. 2013). Educational practices in simulation involve active learning, collaboration, diverse ways of learning, and high expectations. For students to maximize simulation activity, they should be informed with objectives and learning outcomes as to what to expect (Taylor 2004; Roy et al. 2017).

In dentistry, simulation based-learning is implemented via simulation equipment such as the mannequin. Before the start of the simulation experience, students are given lectures and are shown pictures and models from which they can refer to. The faculty will then assess the performance and product according to specific criteria. Students are then given feedback. The commencement of advanced simulators can potentially influence and change how faculty handle simulation teaching. Dental educators may find the advanced simulators as a replacement of actual patients in certain kinds of the dental procedures (Buchanan 2001). Feedback in simulation laboratory procedures in dentistry entails the continuous comment of faculty in every procedure before proceeding to the succeeding step. Virtual reality simulators (VRS) provide instant feedback to learners and should be integrated as an essential part in modern dental simulation laboratory training (Roy et al. 2017). The use of VRS as perceived by their participants helped in the improvement of psychomotor performance of students particularly ergonomics and technical performance (Gottlieb et al. 2011). VRS cannot replace traditional teaching method nor the faculty (Roy et al. 2017). However, if advanced-technology simulators could be offered with case-based scenarios in dental education, it could give opportunity for a broader range of simulation experience that further improves students' competence and confidence (Buchanan 2001). There is need in simulation-based dental education to construct clinical situations that could stimulate critical thinking among students to be able to apply what knowledge they have learned in the classroom (Allen & More, 2004).

Dentistry has been using various types of simulators ranging from the traditional phantom heads and mannequin to haptic and virtual reality (VR) models. These simulators can be used in operative dentistry, prosthodontics, periodontics, and endodontics. The goal is to duplicate a clinic-like scenario wherein students can perform clinical procedures to develop their psychomotor skills. A traditional dental simulation is composed of typodonts embedded in articulator placed in a mannequin or phantom head to mimic the head and oral cavity of live patients. The role of the faculty is to supervise the student while in the simulator, to evaluate his/her performance, and to give feedback to the student's performance. Some dental schools in other countries use a much-improved simulator, but they still apply the same basic simulation teaching and learning system. Exposing students to clinic-like scenarios can enhance their migration from pre-clinical to clinical level (Jasinevicius et al. 2004). A highly-effective simulation learning should be stated, planned, scheduled, implemented, and evaluated, thus it should be integrated in the curriculum (Motola et al. 2013).

The School of Dentistry of Emilio Aguinaldo College uses traditional simulation training in pre-clinical courses. The students undergo psychomotor enhancement with the use of simulators in operative, endodontics, and prosthodontic subjects. The articulators with typodonts are placed inside the simulators. Different procedures are done on typodonts. They are supervised and evaluated by the faculty -in-charge. Feedback is given after the session to ensure that psychomotor skills the students have developed will be transferred to clinical practice. However, this is not always the case. Students find difficulties when transitioning from simulation to treating actual patients. This study is to determine gaps in teaching and learning at the simulation activities so that they can be addressed by the members of the faculty.

The above interrelated concepts indicate the significance of simulation training in preclinical dental education in developing psychomotor skills and confidence in clinical practice. These concepts assisted the researchers in understanding the perceptions of the clinicians on simulation-based

education that could serve as guidelines to create a well- planned simulation activity enabling students to develop competence and confidence that could be translated to clinical practice.

The study aims to determine the effectiveness of simulation design and educational practices in preclinical dentistry at EAC School of Dentistry. Specifically, it aims to determine the following:

1. The extent of implementing a simulation design as perceived by students in terms of (a) objectives and information (b) support (c) problem solving (d) feedback/ guided reflection (e) fidelity/ realism.
2. The extent of educational practices used in simulation in terms of: (a) active learning (b) collaboration (c) diverse ways of learning (d) high expectations.
3. The effectiveness of simulation at EAC School of Dentistry as perceived by students.
4. The differences between expectations and experiences of students on simulation.
5. The relationship between educational practices/simulation design and effectiveness.
6. The effect of simulation on students in terms of learning satisfaction and confidence in learning.

Results of the study will be used in improving simulation exercises at EAC School of Dentistry to develop competence and confidence in clinical practice.

MATERIALS AND METHODS

The study utilized descriptive study design using self-administered questionnaire (SAQ) with informed consents and focus group discussion (FGD). Questionnaires were adopted from the National League of Nursing and minor changes were applied such as the replacement of the word "nursing" to "dental" to make it relevant to dentistry. Questionnaires include Simulation Design Scale (alpha: 0.92), Educational Practices Questionnaire (alpha: 0.91), Student Satisfaction (alpha: 0.94) and Self-Confidence in Learning (alpha: 0.87). The Simulation Design Scale is a 20-item questionnaire which uses a five-point scale analysis with a Cronbach alpha of 0.92. It details on the use of simulation in preclinical level evaluate the five design features of the instructor-developed simulations used in NLN/Laerdal study namely: objectives and information, support, problem solving, feedback, and realism or fidelity. The Educational Practices Questionnaire is composed of 16 questions with a five-point scale that evaluates the presence of four educational practices derived from the study of Chickering and Gamson (1987) namely active learning, collaboration, diverse ways of learning, and high expectations in the preclinical simulation activities. The reliability of the scale using Cronbach's alpha measures 0.86 for the presence of best practices and 0.91 for their importance in simulation (Jeffries and Rizzolo, 2006 in Zapko et al 2017). The third questionnaire used in the study is the Simulation Effectiveness Tool which is a 13-item instrument with a five-point scale. Five items measure the student satisfaction on simulation learning with Cronbach alpha of 0.94 and the remaining eight items measure the self-confidence in learning with Cronbach alpha pf 0.87. (Unver et al, 2017). Technical and ethical approvals were sought from EAC Ethics Review Committee. Students who have undergone simulated training in their preclinical dental subjects such as Restorative Dentistry, Prosthodontics, and Endodontics were invited to participate. Total enumeration of the population was used in the study. Fifty-two (52) out of fifty-five (55) students answered the SAQs. FGD with selected third and fourth year clinicians who have finished simulation activities in pre-clinical subjects and faculty members teaching subjects with simulation activities was also done to obtain in—depth insights regarding learning and teaching of preclinical subjects through simulation. The inputs of the discussants were recorded, transcribed, and summarized. Data gathered from the questionnaires

were analyzed using IBM SPSS version 25 and underwent descriptive (mean) analysis. Inferential statistics (t-test, Pearson's r and Regression analysis) were used to compare the experience and expectation of students in simulation designs and simulation educational practices and the effectiveness of simulation as perceived by clinicians. Significance level was established at p=0.05.

RESULTS AND DISCUSSION

The interpretation of the results of the survey using the instruments were based on the specific problems raised in the study. Data were analysed based on simulation design features, educational practices, and effectiveness tool rather than the individual questions on the survey forms.

> The extent of implementing a simulation design as perceived by students in terms of (a) objectives and information (b) support (c) problem solving (d) feedback/ guided reflection (e) fidelity/ realism.

Table 1: Simulation Educational Practice Experiences and Expectations of EAC Dentistry Students and Its Differences

Educational Practices	Experience
Objectives and Information	4.12(±0.52)
Support	3.93(±0.72)
Problem Solving	4.17(±0.66)
Feedback	4.13(±0.55)
Realism or Fidelity	3.91(±0.93)
Overall	**4.06(±0.51)**

The extent of implementing simulation design requirements is measured through the experience and expectation of the clinicians in their simulated learning. In Table 1, it can be gleaned that the clinicians experienced a high extent of implementation of simulation design features, except for *support* (mean score of 3.93) and *realism* (mean score of 3.91). Most of the participants scored highly the design features: objectives and information, problem solving, and feedback.

Results showed that support and realism have low scores. Support from dental simulation activity comes from the faculty instructor. Using traditional simulators in dentistry requires the presence and assistance of the faculty during the simulation activity to evaluate the procedure being performed by the student. Faculty should go to one simulator to another to be able to assess the procedure that the student is working on for constant feedback on their work. Dental faculty has this challenge to check all the students but may not be able to accomplish all the time. Teaching clinical simulation is most of the time tedious (Arigbede et al. 2014). Lack of support is one of the difficulties in good simulation experience for students (Zitzelsberger et al. 2017). Several studies show that authentic scenarios are significant to experiential learning in simulation. Realistic clinical scenarios could support real-life experiences (Bland et al. 2014; Koivisto et al. 2017). Most dental schools use the traditional and simple way of simulation learning with use of mannequins wherein students prepare tooth preparations and restorations on typodont in an articulator placed in a mannequin's head. Realistic simulated patient that imitates real patient conditions, enhances ergonomics and offers an active learning ambiance should be used in dental simulation learning (Buchanan 2001).

The extent of educational practices used in simulation in terms of: (a) active learning (b) collaboration (c) diverse ways of learning (d) high expectations.

Table 2: Educational Practices in Simulation in EAC Dentistry

Educational Practice	Experience
Active learning	4.10(±0.57)
Collaboration	3.88(±1.00)
Diversity	4.20(±0.73)
High Expectations	4.23(±0.70)
Overall	**4.11(±0.63)**

It is shown in table 2 that the clinicians have experienced a high extent of simulation educational practices in terms of active learning, diversity, and high expectations. Collaboration got the lowest mean score of 3.88. The respondents agreed on great involvement of educational practices: active learning, diversity and high expectations in their pre-clinical simulation experience.
In simulation educational practices, clinicians gave collaboration the lowest score. Lateef (2010) enumerated the skills which can be developed through simulation learning with the involvement of active learning and collaboration: skills in technical and functional expertise, skills in problem-solving and decision-making, skills in interpersonal and communications or team-based competencies. Pre-clinical students are considered novice learners and therefore need to be trained individually to improve their psychomotor skills. Dental simulation exposes learners to simulation experiences related to individual needs. Individualized learning is not merely working alone but it requires that the individual should be responsible for his own progress (Motola et al. 2013). Interaction of individuals is necessary for multidisciplinary task in some clinical settings. In dental simulation, the only interaction that is provided is the student-faculty interaction for constant feedback. The advent of virtual reality simulator (VRS) could offer an immediate feedback on the work and performance of the students can cause the decline of student-teacher interaction during simulation activity (Gottlieb et al. 2011).

The effectiveness of simulation at EAC School of Dentistry as perceived by students.

Table 3: Simulation Effectiveness as Perceived by EAC Dental Students

Educational Practices	Mean(SD)
Pre-briefing	2.69(±0.38)
Scenario	2.53(±0.37)
Debriefing	2.65(±0.40)
Overall	**2.57(±0.34)**

The simulation effectiveness tool has three components namely pre-briefing, scenario, and debriefing. Table 3 shows the perception of clinicians on the effectiveness of simulation. All three phases got a high mean score with an overall mean score of 2.57. The participants of the study agree that simulation is effective in developing their competence and confidence in clinical practice.

Despite the weaknesses of the simulation design and simulation educational practices, the clinicians viewed simulation as an effective method to improve their competence and confidence in clinical practice. There are "transition problems" that students may encounter when applying the skills, they have learned in pre-clinical to clinical practice (Arigbede et al. 2014).

The differences between expectations and experiences of students on simulation.

Table 4: Differences Between Expectations and Experiences of EAC Students on Simulation Design

Educational Practices	Experience	Expectations	t-value	p-value
Objectives and Information	4.12(±0.52)	4.42(±0.65)	-3.43	.001*
Support	3.93(±0.72)	4.43(±0.70)	-4.49	.000*
Problem Solving	4.17(±0.66)	4.33(±0.61)	-1.53	.132
Feedback	4.13(±0.55)	4.36(±0.59)	-3.08	.003*
Realism or Fidelity	3.91(±0.93)	4.36(±0.83)	-3.40	.001*
Overall	**4.06(±0.51)**	**4.37(±0.53)**	**-4.33**	**.000**

@ 0.05 level of significance

Table 4 shows that there is significant difference between the experience and expectation of the clinicians on objectives and information, support, feedback, and realism. The experience of the clinicians on these design features is less than their expectation. This disparity is a reflective of the simulation system in dentistry which lacks a more realistic simulation patient. On the other hand, there is no significant difference on simulation design on problem solving requirement with t-value = -1.53; p-value of .132.

Table 5: Differences between Expectations and Experiences of EAC Students on Educational Practices

Educational Practice	Experience	Expectations	t-value	p-value
Active learning	4.10(±0.57)	4.31(±0.53)	2.77	.008*
Collaboration	3.88(±1.00)	4.08(±0.82)	1.68	.098
Diversity	4.20(±0.73)	4.31(±0.74)	1.13	.263
High Expectations	4.23(±0.70)	4.36(±0.69)	1.41	.164
Overall	**4.11(±0.63)**	**4.26(±0.60)**	**1.80**	**.077**

@ 0.05 level of significance

Table 5 illustrates that the expectation and experience of clinicians in simulation educational practices showed no significant difference except for active learning. Their experience on collaboration, diversity, and high expectations is comparable to their expectations. However, clinicians have a higher expectation on active learning (t-value = 2.77; p =.008). This is a vital gap that faculty should be aware of and should be addressed to ensure a more meaningful simulation experience of students. Results show that there is discrepancy between the experiences of clinicians on simulation and their expectations on some of the feature designs and practices of simulation. Norman (2012), Rickets (2011), Topping et al (2015) emphasized that in order to sufficiently

equipped students with competence and confidence in clinical situations, their experiences on simulation-based learning must be intensified (as cited in Zitzelsberger et al. (2017).

The difference between the experience and expectation of the clinicians on objectives and information, support, feedback, and realism may be attributed to a high student-faculty ratio and the inconsistency among raters (Arigbede et al. 2014). This predicament can be solved by using the virtual realistic simulator which offers more realistic patient conditions and could provide immediate and constant feedback (Roy et al. 2001). VRS reduces the time of faculty supervision (Tavkar & Pawar, 2017). Based on the focus group discussion with clinicians, they have expressed their sentiments on not being able to respond to difficult to handle patients, minor or major dental mishaps, and difficult dental procedures. They added that they feel the need to be trained on how to handle these scenarios. Realistic environment in simulation learning provides students to enhance their cognitive, affective and psychomotor skills thus having less medical errors (Eyikara & Baykara, 2017). This is what is lacking in a low-fidelity simulator in which dental mannequins belong to. Clinicians have high expectation on active learning than on what they have experienced in pre-clinical simulation activities. This could be ascribed to the fact that dental simulation involving the simple mannequin only develops psychomotor skills of students. Clinicians may have experienced some complications in the clinics that they only read in the books or in the lectures of their professors. During FGD, clinicians voiced out that they were not prepared for these kinds of difficulties. Knowledge and skills learned in the classroom can be transferred the into real-world practice and not merely memorization of facts and concepts (Roy et al. 2017).

The relationship between Educational Practices/Simulation Design and Effectiveness.

Table 6: Relationship Between Educational Practices/Simulation Design and Effectiveness

Variables	r-value	p-value
Educational Practices		
Prebriefing	.338	.014*
Scenario	.300	.031*
Debriefing	.434	.001*
Simulation Design		
Prebriefing	.414	.002*
Scenario	.392	.004*
Debriefing	.539	.000*
Overall		
Educational Practices	.394	.004*
Simulation Design	.491	.000*

@ 0.05 level of significance

Table 6 shows that educational practices and simulation design in EAC are significantly effective in all phases as perceived by EAC dental clinicians. This also came out in the FGD. The clinicians consider the simulation activity done in pre-clinical courses as effective in preparing them to clinical practice but desired more realistic simulation activities.

The clinicians consider the simulation activity done in pre-clinical courses effective in preparation for clinical practice. Simulation based learning can be an efficient tool in exposing students to simulation situation and scenarios that depicts clinical case that students may encounter during their clinical practice (Lateef 2010).

The effect of simulation to the students on: (a) learning satisfaction (b) confidence in learning.

Table 7: Predictive Analysis of Simulation Effectiveness

Variables	Effectiveness of Simulation				
	B	SEB	β	t-value	p-value
Educational Practices	.211	.069	.394	3.03	.004*
Simulation Design	.331	.084	.491	3.95	.000*

@ 0.05 level of significance

Table 7 shows that the clinicians perceived that educational practices and the simulation designs in EAC pre-clinical courses are crucial in giving them satisfaction and confidence to work in clinical practice. This was also corroborated by the results of the FGD. It can be concluded that the clinicians perceived that educational practices and the simulation designs in EAC pre-clinical courses are crucial in giving them satisfaction and confidence to work in clinical practice. Simulation-based learning provides a controlled and safe environment in enhancing efficiency in clinical practice thus it helps learners on how to deal with unexpected medical events increasing their confidence (Lateef 2010).

In general, simulation increased the satisfaction and confidence in learning of students prior to clinical dentistry.

CONCLUSIONS

EAC Dentistry students experienced and expected high extent of simulation design requirements. Emphasis on support and realism is highly encouraged.
EAC Dentistry students experienced and expected high extent of simulation educational practices, but collaboration needs enhancement.
Dental simulation is considered highly effective in all phases.
Experiences on active learning, objectives, support, feedback and realism seemed to be less than students' expectations.
Good simulation design and educational practices can yield positive learning experience.
EAC dental students expressed increased self-confidence, satisfaction and learning through simulation.
The study is limited to general aspects of simulation in pre-clinical dentistry

RECOMMENDATIONS

The authors recommend the following: Further exposure to simulation activities prior to actual clinical exposure to increase students' confidence and learning. Restructuring of the simulation activities will be conducted to maximize the impact of this learning strategy. Emphasis will be given to inter-professional education and exposure, health education, communication, critical thinking and holistic approach to dental patients. Further study on simulation specific to disciplines of clinical dentistry like prosthodontics, endodontics, and operative dentistry

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