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Original Article

Effectiveness of a training program based on maker education for baccalaureate nursing students: A quasi-experimental study

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ABSTRACT

Objectives: Maker education is a dominant force in education reform and is viewed as a revolutionary way to learn. As innovative pedagogy is continuously explored in the field of nursing, the emerging role of maker education must be examined. This research aims to build a nursing bachelor education program based on maker education and to evaluate the effectiveness of this program.

Methods: Forty volunteer junior students majoring in nursing from a college were the subjects for this quasi-experiment. The training program for nursing students based on maker education was developed and implemented as an additional class for a period of 12 weeks. Before and after the experiment, two measures including the “Williams Creative Scale” and “Current Status Questionnaire of Nursing Students’ Learning” were adopted for investigation, and corresponding statistical methods were used for analysis. The degree of satisfaction with this training program was investigated after the experiment.

Results: The average scores of creativity, learning interest, cooperative learning skill, scientific research ability, and information attainment of the nursing students after the implementation of maker education all improved. The differences in the above points before and after the experiment were all statistically significant ($P < 0.05$). Most of the students expressed satisfaction with this training program (72.5% were very satisfied, 15.0% were partially satisfied, and 12.5% were not satisfied).

Conclusion: Implementing the training program based on maker education enhanced student creativity, learning interest, cooperative learning skill, scientific research ability, and information attainment. Comprehensive nursing talents were also cultivated. Our data suggested the importance of improving this program, adopting the method, and pursuing research in nursing education.

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1. Introduction

Modern concepts, such as health concept, quality of life, and health quotient have greatly expanded the current medical

function and nursing fields. Meanwhile, numerous technologies and modes of instruction are used in nursing education and clinical care [1,2]. As the main organizations for nursing professional personnel training, colleges and universities have progressively put forward that “high quality, comprehensive nursing talents should be cultivated and trained” [1,2]. In the field of comprehensive personnel training, maker education has aroused great public concern in recent years, and its concept of cultivating students’ multiple abilities is gradually taken seriously [3]. After realizing the importance of cultivating comprehensive nursing talents and the effectiveness of the maker education mode, this research introduced the maker education mode into nursing education to provide

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new ideas for cultivating comprehensive nursing talents.

2. Background

Makers are persons “who are full of creativity and passion, good at discovery and manufacturing, introduce innovative ideas into work, life, and study, and realize creative ideas and fulfill new demands through hard work or teamwork” [4,5]. The integration of “makers” in education is slowly changing the traditional concept, mode, and method of education [5,6]. Maker education is a form of education under the guidance of cultivating maker attainment of the general public, including both formal learning and informal learning throughout life [7]. The ultimate goal of maker education is to cultivate students’ creative personality. The theory is based on concepts, such as experiential education, project-based learning, Do it Yourself (DIY), and Do it Together (DIT) [8,9]. Since *Nature* reported and discussed the Fab Lab initiated by the Center for Research of Bits and Atoms of Massachusetts Institute of Technology in 2006, the idea of maker and maker education began to spread globally. According to an incomplete statistical study, more than 60 American universities, including the University of Massachusetts Lowell, University of Wisconsin, and the University of Mary Washington, are gradually implementing maker education. The target population of the programs is mostly students in science and engineering, liberal arts, and arts but rarely for students in the medical disciplines. In China, more than 20 universities are currently implementing maker education gradually, including Tsinghua University, Tongji University, and Wenzhou University. The majority of the universities explored maker education as an additional class or general education. A standardized maker education mode as a research outcome is not yet developed and applied to majors, such as science and technology, literature, and arts.

In the field of health care, nursing education is a major way to cultivate nursing professionals. Nursing education encompasses activities of cultivating nursing professionals who possess profound medical, humanistic, and nursing knowledge and provide service for human health [10]. After years of development, nursing education has become a relatively comprehensive teaching system. However, in some institutions, problems exist in terms of reforming pedagogy in education, competencies in specialty, and asynchronous theory and practice [11]. As a comprehensive discipline integrated from fields, such as science, humanity, and social science, nursing science shows complex interdisciplinary characteristics. The complex demand in nursing calls for nursing education to cultivate integrated nursing talents. From the connotation of maker education, the maker education model attaches great importance to the reconstruction of teaching and learning modes, provides online and offline integrated digital teaching environments, and emphasizes autonomic, ubiquitous, social, exploratory, and interactive learning [7]. Therefore, theoretically speaking, the introduction of the maker education mode into nursing education can improve nursing students’ ability to solve problems flexibly by cultivating their creative thinking and perfects students’ professional skills through innovative and improved operation training in which they are interested [11,12]. Moreover, students can also practice their skills in communication, information management, and the application of modern scientific technologies, which are necessary for the comprehensive talents in the new era [13].

2.1. Key points

- (1) Maker education derived from the concept of a maker from the US has explosively spread worldwide. Maker education is

integrated into a variety of educational theories, and to a certain extent, meets the requirements of modern education.

- (2) Currently, no research supports the application of maker education related thought, theory, or mode into nursing education.
- (3) The demands of a nursing profession requires the core of nursing education reform to cultivate students’ humanistic quality and practice ability, spirit of seeking truth and innovation consciousness, and to explore nursing education based on maker education for the cultivation of comprehensive nursing talents.

2.2. Operational definitions

- (1) Baccalaureate nursing students refer to students studying in a nursing college after the national college entrance exams.
- (2) Creativity refers to the results measured by the Williams Creative Scale.
- (3) Nursing maker education refers to an educational form that encourages nursing students to regard creative-based learning as the most fundamental way of learning, and to pay enough attention to the use of innovative educational tools and resources.
- (4) Nursing maker space refers to a place created in the field of nursing specialty. It has some of the characteristics of nursing science and maker space, wherein nursing teachers and students can carry out creative activities.

3. Innovation

The innovation of this study is the application of maker education into nursing education for the first time and the exploration of a new nursing bachelor education program based on maker education from the perspective of nursing specialty.

4. Aims

The aims of this research study are as follows: (1) to build a nursing bachelor education program based on maker education and (2) to implement and to evaluate the effectiveness of the program.

5. Methods

5.1. Research team

In this study, 14 faculty members were organized as the research core team, including nursing education experts, nursing teachers, maker education advisers, and teaching managers (Table 1).

5.2. Design

A college-wide survey on the existing problems in nursing education, especially on cultivation of comprehensive nursing talents, was conducted through suggestion boxes, interviews, and questionnaires. Collected problems were collated and analyzed by the research team through literature review and discussion. The common themes on the existing problems on the cultivation of comprehensive nursing talents can be summarized in the following three aspects: (1) being confined by education and teaching concepts; (2) shortage of external environmental resources; and (3) lack of personal motivation in the students [14–17]. Integrating the characteristics of maker education and the discipline attribute of nursing science, the maker education method was then introduced

Table 1
Core team members and responsibilities.

Title	Number	Sex	Qualifications	Working experience (years)	Responsibilities
Professor	1	Female	Master	32	Teacher training, teaching instruction
Associate Professor	2	Female	Undergraduate	20–33	Teaching management, teacher training, teaching instruction
Lecturer	10	6 Male 4 Female	1 Doctor 2 Master 7 Undergraduate	5–20	Teaching practice, participation in reflection, discussion and action amendment
Teaching Assistant	1	Female	Master Candidate	1	Materials collection, data analysis, participation in reflection, discussion and action amendment

into routine teaching. Maker education was studied, and the nursing bachelor education program was implemented based on maker education model in selecting the study subjects evaluating the effectiveness of the program. Before and after the experiment, the results were investigated using the questionnaire and the scale.

5.3. Establishment of nursing bachelor education program based on maker education

The nursing bachelor education program based on maker education was developed by addressing the existing problems recognized in the previous education of the nursing students, and other characteristics of maker education were applied (Table 2). The program used experiential education, project-based learning, maker education, DIY, and DIT as the educational theory, whereas professional and cross-border education, school and extramural education, and theoretical and skill education are the key points. The specific learning task (maker education) was the center to cultivate the students' innovative thinking and the ability to find and solve problems. The plan was formulated over a period of two months, during which the Delphi Method was tested through two rounds of inquiry by 15 experts. The specialist authority coefficient (Cr) of the two rounds of inquiry of the two categories, judging basis coefficient (Ca) and specialist familiarity coefficient (Cs), were 0.845 and 0.873, respectively; values above 0.7 indicate that the degree of authority of the experts' evaluation was high. Through Kendall's coefficient of concordance test, the specialist consistency judgment coefficient (Kendall's W) of the experts for two rounds of inquiry was 0.506 and 0.793 respectively; values above 0.5 indicate a good degree of concordance between the experts' evaluation of

the two rounds. Twelve teaching tasks were finalized for this study after the inquiry. One semester was needed to complete all the teaching tasks, and 12 weeks were needed, excluding mid-term exams, final exams, and vacations.

5.4. Evaluation of the effectiveness of the nursing bachelor education program based on maker education

5.4.1. Research objects selection

The students' school time was comparatively centralized to assess the students' willingness through the network within the same grade. Junior students from a nursing college were selected as the test subjects because the maker education equipment sets in a certain campus were relatively complete and due to other factors. The sample size was estimated according to the calculation formula of two sample average of self-control experiment. The formula is " $N_1 = N_2 = 2[(t_{\alpha/2} + t_{\beta})S/d]^2$," where α is 0.05 and β is 0.10, and $t_{\alpha/2}$ is 1.960 and t_{β} is 1.282 from the table. In the pre-survey, $N_1 = N_2 = 31$ were analyzed, which increased the sample size by 20% to a total of 38. Accordingly, 40 volunteers were recruited to meet the demand of sample capacity. The average age was 21.60 ± 1.39 years old, of which 14 students majored in science in high school and 5 were student leaders. According to the students' wishes and their characteristics, the subjects were divided into 5 heterogeneous groups, wherein each group comprises eight students, one nursing teacher, and one maker education adviser.

5.4.2. Implementation of the education program

After assessing the 40 students' extracurricular time, maker teaching was carried out every Tuesday afternoon with a teaching

Table 2
Nursing bachelor education program based on maker education.

Teaching Task		Teaching Form		Teaching locations		Output Form				Class hour	Teaching time
Serial number	Content	On line teaching	Off line teaching	In school	Outside school	Class discussion	Slide report	Written report	Physical display		
1	Develop innovative thinking		✓	✓		✓				4	Week 1
2	DIY		✓	✓					✓	4	Week 2
3	Internet + nursing	✓	✓	✓		✓				4	Week 3
4	Methodology of scientific research		✓	✓		✓		✓		4	Week 4
5	Social practice survey		✓		✓			✓		4	Week 5
6	Approval of maker project		✓	✓			✓			4	Week 6
7	Cognition and Application of Maker tool		✓	✓					✓	4	Week 7
8	Programming	✓	✓	✓		✓				4	Week 8
9	Development and application of educational games	✓	✓	✓		✓				4	Week 9
10	3D printing and medical care		✓		✓				✓	4	Week 10
11	Patent application		✓	✓		✓				4	Week 11
12	Conclusion and achievement exhibition of the maker project		✓	✓			✓		✓	4	Week 12

Note:1 class hour = 40 min.

task completed weekly. The teachers were those from the research team or external experts in a related field. The teaching materials were created or reorganized by the teachers. The teaching objectives, methods, contents, and requirements of each teaching task are not listed one by one in this article due to space limitation. The whole study spanned 1 semester, 16 weeks, including 1 week of midterm exams, 1 week of holiday, and 2 weeks of final exams so the effective research time lasted for only 12 weeks.

5.5. Data collection

The research subjects were investigated through the Williams Creative Scale and the Current Status Questionnaire of Nursing Students' Learning before and after the experiment. We also investigated the degree of satisfaction with the training program based on maker education after the experiment. (1) Williams Creative Scale was used to measure the students' creativity and is recognized all over the world. The scale was compiled by Williams and revised by Chinese scholars according to the characteristics of Chinese culture and medical students. The Williams Creative Scale has good reliability and validity (each dimension and the total volume table Cronbach's $\alpha = 0.29\text{--}0.82$); the correlation analysis indicated a moderate correlation among various dimensions, and each dimension was highly correlated with the total questionnaire with a significant level at 0.01, which basically explained the validity of the questionnaire [18]. The scale includes 4 dimensions and 50 questions. The hierarchy was divided using the Likert 3 grade score (Table 3). (2) Current Status Questionnaire of Nursing Students' Learning was used to measure some students' learning status. The questionnaire showed good reliability and validity by testing. The Cronbach's α and content-related validity of the questionnaire were 0.88 and 0.97 respectively. It contains 4 dimensions (learning interest, cooperative learning ability, scientific research ability, information attainment) and 10 questions, and the Likert 3 grade score was used.

5.6. Data analysis

The data collected through questionnaire and scale were input by two people. SPSS 21.0 software was used for data analysis. Measurement data were expressed as $Mean \pm SD$. Measurement data between two groups were compared by two independent sample *t*-test and multivariate variance analysis. Enumeration data were expressed as frequencies and percentages. Enumeration data between the two groups were compared by using χ^2 test. All tests were two-tailed tests, and differences with $P < 0.05$ were statistically significant.

5.7. Ethical consideration

The Williams Creative Scale used in this study is a widely used scale for measuring creativity tendency. The developer of the scale authorized researchers to use the scale to test creativity tendency. This study was approved by the ethics review committee of the college. All of the participants were volunteers and were informed of

the purpose and ethical requirements of the study. Before the study, all participants voluntarily submitted written informed consent and indicated that they can withdraw from the study at any stage. All collected data and text information were stored in an encrypted computer. All information was confidential and without public access. Data were only available to the authors for processing.

6. Results

Before and after the test, 40 copies of Williams Creative Scale were handed out to the volunteers, and the same numbers of scales were taken back (a recovery rate of 100.0% and effective rate of 100.0%). Before and after the test, 40 copies of the "Current Status Questionnaire of Nursing Students' Learning" were handed out to the volunteers and the same numbers of questionnaires were taken back (a recovery rate of 100.0% and effective rate of 100.0%).

6.1. Test results on creative tendency of nursing students

Before the experiment, the creativity tendency test results showed that 4.7% of the nursing students had excellent creative tendencies, 30.3% of them had good creativity tendencies, and 65.0% of them were normal. After the experiment, the creativity tendency test results showed that 20.0% of the nursing students had excellent creative tendencies, 65.1% of them had good creativity tendencies, and 14.9% of them were normal. The average total score of the creativity tendency of the nursing students after the implementation of maker education increased by 18.2%. The average scores on the 4 dimensions, including curiosity, adventure, imagination and challenge, increased by 18.6%, 18.9%, 22.7%, and 12.4%, respectively. The creativity tendencies before and after the experiment have statistically significant differences ($P < 0.05$; Table 4).

6.2. Investigating results on learning status of nursing students

The differences on nursing students' learning interest, cooperative learning skill, scientific research ability, and information attainment before and after the experiment were statistically significant ($P < 0.05$). All subordinate items of the four main factors, except the item of nursing students' network data storage ability under information attainment ($P > 0.05$), were statistically significant before and after the experiment ($P < 0.05$; Table 5). The degree of satisfaction with the training program based on maker education was investigated after the experiment. The survey results showed that 72.5% of students expressed high satisfaction with this teaching model, 15.0% of students expressed partial satisfaction, and 12.5% of the students were not satisfied.

7. Discussion

7.1. Effect of training program based on maker education on creativity tendency of nursing students

The average scores on the four dimensions, including curiosity,

Table 3
Hierarchy of creativity (score).

Project (number of questions)	Maximum score	Excellent	Good	General
Curiosity (14)	42	>36	30–36	<30
Adventure (11)	33	>30	25–30	<25
Imagination (13)	39	>35	29–35	<29
Challenge (12)	36	>32	27–32	<27
Total (50)	150	>133	111–133	<111

Table 4Comparison of the total scores and scores at different dimensions on the creative tendencies of nursing students (*Mean ± SD*).

Project	Before the test (<i>n</i> = 40)	After the test (<i>n</i> = 40)	<i>t</i>	<i>P</i>
Curiosity	28.08 ± 3.17	34.50 ± 3.43	−8.690	<0.001
Adventure	21.83 ± 2.85	26.90 ± 2.64	−8.257	<0.001
Imagination	23.28 ± 3.15	30.13 ± 3.48	−9.224	<0.001
Challenge	25.95 ± 3.11	29.63 ± 2.69	−5.653	0.001
Total	99.13 ± 10.29	121.15 ± 9.42	−9.980	<0.001

Table 5Comparison of nursing students' learning status [*n*(%)].

Investigating items		Before the test (<i>n</i> = 40)	After the test (<i>n</i> = 40)	χ^2	<i>P</i>
Learning interest					
I have a strong interest in professional learning.	Very consistent	15(37.5)	26(65.0)	6.330	0.042
	Partial consistent	13(32.5)	6(15.0)		
	Inconsistent	12(30.0)	8(20.0)		
I have a strong interest in cross-border learning (Mathematics, Physics, Materialogy, etc.)	Very consistent	10(25.0)	25(62.5)	13.029	0.001
	Partial consistent	18(45.0)	12(30.0)		
	Inconsistent	12(30.0)	3(7.5)		
Cooperative learning skill					
I am willing to cooperate with other students to learn in class.	Very consistent	18(45.0)	31(77.5)	10.569	0.005
	Partial consistent	11(27.5)	7(17.5)		
	Inconsistent	11(27.5)	2(5.0)		
I am willing to cooperate with other students to explore and solve problems outside class.	Very consistent	16(40.0)	29(72.5)	11.095	0.004
	Partial consistent	10(25.0)	8(20.0)		
	Inconsistent	14(35.0)	3(7.5)		
I can undertake the tasks on my own initiative in team learning.	Very consistent	18(45.0)	30(75.0)	9.704	0.008
	Partial consistent	11(27.5)	8(20.0)		
	Inconsistent	11(27.5)	2(5.0)		
Scientific research ability					
I know how to write a scientific research plan.	Very consistent	8(20.0)	20(50.0)	8.585	0.014
	Partial consistent	17(42.5)	13(32.5)		
	Inconsistent	15(37.5)	7(17.5)		
I am able to observe and record information about research.	Very consistent	12(30.0)	36(90.0)	31.200	<0.001
	Partial consistent	16(40.0)	4(10.0)		
	Inconsistent	12(30.0)	0(0.0)		
I can analyze the research data accurately using appropriate statistical methods.	Very consistent	10(25.0)	26(65.0)	18.154	<0.001
	Partial consistent	14(35.0)	12(30.0)		
	Inconsistent	16(40.0)	2(5.0)		
Information attainment					
I can master how to use the network resources (such as online courses, special learning website, etc.) to learn.	Very consistent	20(50.0)	31(77.5)	10.765	0.005
	Partial consistent	9(22.5)	8(20.0)		
	Inconsistent	11(27.5)	1(2.5)		
I can store my network information, personal information, etc. safely in case of theft or loss.	Very consistent	24(60.0)	32(80.0)	5.714	0.057
	Partial consistent	5(12.5)	5(12.5)		
	Inconsistent	11(27.5)	3(7.5)		

adventure, imagination and challenge of the nursing students after the implementation of the training program based on maker education all increased. The highest increase was imagination and the lowest was challenge. The main reasons for the increases were as

follows. (1) Curiosity: the implementation of the maker education model brought students new technologies, such as 3D printing, open source software and hardware, and knowledge and technology outside their major, therefore driving their curiosities. (2)

Adventure: the implementation of the interdisciplinary training program based on maker education created a learning environment such as that of the “samba school” style. The interdisciplinary training program encouraged teachers to implement inquiry teaching with no fixed teaching outlines, required students to break the passive learning mode under the traditional classroom teaching system, and cultivated abilities to accept new knowledge and to explore. (3) Imagination: we developed a number of programs for honing students’ innovative thinking, such as an exercise in the “6 thinking hats” and brainstorming. In the 9th week of the program, thinking presentation tools, such as the “mind map” and “concept map” was provided to the students. These targeted trainings are beneficial to students’ divergent and convergent thinking and the main parts of imagination cultivation [3]. (4) Challenge: to set up the education program that integrated multiple subjects. This education program included nursing knowledge and involved disciplines such as psychology (“creative thinking development” in the first week), art (“DIY” in the second week), computer science (“programming” in the 8th week), and mathematics (“3D printing and medical treatment” in the 10th week), thereby presenting some challenges for nursing students. The innovation of teaching contents and forms stimulated student interest in learning; however, some students were happy to face the challenges brought by the new knowledge, whereas other students easily held back in facing challenges.

Results of multivariate variance analysis on the creativity tendency of nursing students showed that the fitting degree of the model to the data was not ideal, indicating that other factors besides the training program based on maker education, influenced the results of the nursing students’ creativity tendency evaluation. Other factors will be explored and tested in follow-up research because the present study was only at an initial stage and only involved the students in one grade.

7.2. Impact of the training program based on maker education on nursing students’ learning

Studies have shown that the implementation of a training program based on maker education improved students’ learning interest, cooperative learning skills, research skills, and information attainment. The main reasons for the improvements were as follows: (1) Learning interest: the teaching theory of innovative education was applied. The diversified and rich media teaching resources allowed the integration of traditional classroom teaching with instructional videos, educational game software, and other internet resources, thereby enriching the teaching environment, teaching contents and forms, increased students’ interest, and optimized the teaching results [19,20]. In the assessment of learning interest, results showed that students’ interests in multi-disciplinary knowledge were improved, and their interest in a nursing major increased from 37.5% to 65.0%. These data indicate that this teaching form was beneficial to both unplanned and planned teachings. (2) Cooperative learning skill: This education program has the characteristics of a learning community, which is formed by the learners and the helpers (including nursing teachers and maker education advisers). The learners interacted with each other during the learning process, shared the study resources to complete certain learning tasks, and formed a corporative learning relationship with mutual influence and support. (3) Scientific research ability: cultivation of scientific research ability is an important part of students’ learning process [21]. In the process of implementing the training program, we used the theory of project teaching, which instilled scientific thinking and ability training into students in accordance with the maker project as the mainline of maker education. We also taught the theory of experiential

education. Scenarios were designed based on special clinical cases so that students can learn from the real experience the unity of learning and research. (4) Information attainment: We encouraged and taught students to use media, such as cloud storage and sharing, instant communication, mobile intelligent software, and the collaborative visualization software, Pearltrees. Dominant and recessive resources, such as the advanced thinking and concepts, innovative technology, and modern knowledge and skills were shared during the maker project planning, implementation, evaluation, and decision process to strengthen online teaching resources and the frequency of online teaching [22,23]. The application of diversified network teaching resources promoted the students’ ability to obtain network information [22,24,25]. However, the study showed that students’ ability to store information from the Internet was not improved, indicating deficiencies in the design of this study, which emphasized only the output of online teaching and not on the storage management of the output resources, thereby resulting in problems such as network information leakage or low learning efficiency.

Results also showed that this training program was favored by most students. However, 12.5% of the students were still not satisfied. From investigation, some students reflected that the curriculum activities, study materials, and tasks were a little excessive. The main reasons were as follows: first, the experiment involved too much interdisciplinary knowledge and the teachers’ own knowledge was not enough; second, the study subjects were college junior students about to go into the clinics. They may feel that extracurricular learning tasks are too heavy and consumed too much energy, whereas they face pressures from their final exam and thesis defense.

7.3. Study limitations

The main limitations of this study are as follows: (1) the sample size is small, and all the research objects are freshman students, which thus lacks comparison with the different degree of ability enhancements of the nursing students with different backgrounds (different grade, age, and gender) after the implementation of the maker education-based teaching program. (2) The original group was formed from recruitment and was not random due to the quasi-experimental design of this study. Therefore, no proof exists that the research subjects are the random samples of larger population. The deviation from the subject selection can damage the generalizability of the research results because any factor can affect the original group and thereby affect the internal validity of the study [26,27].

7.4. Research recommendations

After reflecting on the teaching process, we concluded that the nursing degree course can be improved by using plenty of resource allocation, improved teaching, and development of teaching activity.

7.4.1. Resource allocation of nursing maker education

The nursing course in this study was developed on the basis of existing teaching resources of certain nursing colleges and laboratories specializing in the development of nursing skills. In light of similar projects, allocating the resources for nurse training solely to the nursing course can be feasible to further improve the specialization of this technique.

7.4.2. Improvement of teaching task of nursing maker education

The goals of maker education decide that the maker education must be an intelligent and interdisciplinary form of education. The

bachelor of nursing program adopted in this study used existing guidelines and implemented them under the instructions of teachers. The next step would be to build the entire curriculum for nursing maker education.

7.4.3. Development of teaching activity of nursing maker education

Based on specialized knowledge, the nursing bachelor education program based on maker education has a multidiscipline and multifunction knowledge construction. Therefore, solving all teaching problems through limited classroom teaching is difficult. The next steps would be to conduct campus activities and convert regular teaching into maker salon or lecture.

8. Conclusion

This study indicated that the implementation of a training program based on maker education has significant advantages on the cultivation of nursing students' innovative thinking, learning interest, cooperative learning skill, scientific research ability, and information attainment. The maker education model has the of the following advantages: openness, compatibility and sharing, integrates multidisciplinary knowledge, practiced through concrete projects, and emphasizes innovation. Thus, its introduction into nursing education provides new ideas for the nursing education reform.

Research on the popularization and application of training programs based on maker education in nursing education should be conducted, and in the follow-up studies, research subjects can be extended to all nursing college students. Cross-sectional research can be conducted with grade as the unit. The essence and law of the teaching process should be studied from the dynamic viewpoint to solve problems, such as timing, frequency, and suitable population in the application of maker education in nursing education.

Conflicts of interest

No conflict of interest is declared by the authors.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ijnss.2018.11.006>.

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