

Educational Methods Used to Teach Infection Prevention and Control in Nurse Training: Survey of French Training Institutes

Stephanie Bouget Mohammadi^{1,2*}, Claire Dinh² and Caroline Landelle^{2,3}

¹French Red Cross Competence Auvergne-Rhône-Alpes, 26000 Valence, France

²Univ. Grenoble Alpes, CNRS, UMR 5525, VetAgro Sup, Grenoble INP, CHU Grenoble Alpes, TIMC, 38000 Grenoble, France

³Grenoble Alpes University Hospital, Infection Control Unit, 38000 Grenoble, France

*Corresponding author

Stephanie Bouget Mohammadi, Croix-Rouge Competence, 76 chemin de Ronde, 26000 VALENCE, France.

Received: March 06, 2024; **Accepted:** March 11, 2024; **Published:** March 14, 2024

ABSTRACT

Context: French nursing students attend classes in Infectiology and Infection Prevention and Control (IPC) during their first semester of training.

Objectives: The aim of this study was to describe the educational techniques used in nurse training to teach IPC and evaluate which factors contribute towards successful exams.

Method: A study was conducted in October 2021 on 320 nurse training institutes in France. An online questionnaire was developed. Factors predicting student success during exams were researched.

Results: In total, 169 institutes took part in the survey, representing 52.8% of all institutes. In these establishments, 91.73% of students passed their IPC examination and the average score was 12.32 out of 20. The exam success rate was significantly linked to the North-West region (Odds Ratio (OR)=1.060, Confidence Interval 95% [CI95%, 1.006-1.117]) and to a number of students higher than 93 (OR=1.034, CI95% [1.004-1.065]) adjusted to the number of educational techniques used. The educational methods applied were varied. There were significant differences in the number of lectures attended and the assessment methods used.

Conclusion: The exam success rate was highly satisfactory but the average score achieved on the exam was not very high.

Keywords: Nursing Students, Pedagogy, Education, Infection Prevention and Control

Context

Healthcare-associated infections (HAIs) account for around 750,000 infections per year and are thought to be the direct cause of 4,000 deaths in France [1]. Simple Infection Prevention and Control (IPC) rules lower the risks of cross-contamination and protect patients, visitors and professionals: these are referred to as Standard Precautions (SP) [2]. These basic IPC rules are taught as part of initial nursing training at the start of training.

In France, nursing training is provided as a university course since 2009. According to the training framework, hygiene education is an Infectiology and IPC course unit (CU) taught during the first 6 months of training [3]. The aim of this CU is to describe infectious agents' mechanisms of action and to identify IPC rules. Learning content includes infectious agents, general immune system structure, HAIs, IPC rules and the means for combatting infection. The training framework provides for 20 hours of Lectures (L), 20 hours of Tutorials (T) and 10 hours of individual guided work (IGW).

Our literature review of IPC knowledge, practices and teaching methods in the context of nursing training did not reveal any studies conducted in France [4]. Twenty-one studies describing teaching methods were identified. Of these, 15 show improvement of knowledge and practices in IPC among nursing students. The introduction of didactic classes has improved knowledge [5,6]. Use of ultraviolet (UV) lamps has improved practices [7]. Regular swabbing of nursing students' hands has reduced microbial flora by raising their awareness of invisible infectious risks. Simulation has also proved effective [8,9]. Use of Virtual Reality (VR) to prevent accidents involving Sharp Objects has proven beneficial [10]. Cooperative learning has improved knowledge of SPs [11]. Various multimodal approaches have proven effective by combining several educational tools: L, demonstrations and videos; L, audits, videos; L, posters, videos, UV lamps and reward system; clinical cases and simulation; e-learning, quizzes and videos; e-learning and simulation and a combination of L and the observation of practices [12-18].

In a broader perspective, a literature review was conducted on 10 studies relating to innovative teaching approaches in nursing

Citation: Stephanie Bouget Mohammadi Claire Dinh, Caroline Landelle. Educational Methods Used to Teach Infection Prevention and Control in Nurse Training: Survey of French Training Institutes. *J Med Clin Nurs Stud.* 2024. 2(2): 1-8. DOI: doi.org/10.61440/JMCNS.2024.v2.43

training [19]. This study showed that traditional teaching has been set aside in favour of teaching that is more suited to how young generations learn. Innovative teaching methods such as flipped classrooms, group work, self-directed learning and the use of interactive learning are approaches that aim to improve the quality of teaching through a more interactive approach to learning. A literature review identified 24 studies on flipped classrooms in nursing teaching, and demonstrated the effectiveness of this method [20]. To our knowledge, no studies appear to have been conducted to describe and evaluate the various educational techniques used to teach IPC in the context of nursing training in France.

The primary aim of this study was to describe the educational techniques used in nursing training to teach IPC in the context of continuing education in France. The second aim was to evaluate the factors contributing towards nursing students' success on exams.

Methods

We conducted a survey targeting the course coordinator in charge of the IPC course unit within each French nursing training institute. The survey was conducted from 1 to 22 October 2021. It was a quantitative survey in the form of a self-administered online questionnaire using Survey Monkey. The questionnaire was tested in advance on volunteering coordinators and subsequently readjusted. The link to the questionnaire was sent by email to the secretary offices or management of all 320 French nursing training institutions (263 public institutes and 57 private non-profit institutes), to be forwarded to a single course coordinator per institute [21]. The link was simultaneously shared on social networks: LinkedIn, and a professional group of course coordinators on Facebook. To encourage participation, a 30-euro bookstore voucher was offered by random draw to a course coordinator having fully completed the questionnaire. A reminder email was sent to each institute having failed to respond within 7 days, and again within 15 days, of the start of the survey.

The questionnaire was comprised of 20 questions, divided into 3 sections. The first section contained compulsory questions relating to the characteristics of the nurse training institute and its teaching methods. Questions included the type and number of classes dispensed (L, T, IGW), the qualifications of the individuals giving the classes (academic, IPC practitioner, registered hygiene nurse, institute course coordinator with a hygienist nursing diploma or without specific IPC qualifications) and the educational techniques used (handouts, L involving a speaker or commenter or digitised in the form of slideshows, flipped classrooms, synchronous or asynchronous quizzes, video capsules, simulation [procedure, role play, involving actors or high-fidelity mannequins], UV lamps, demonstration videos, video analysis, clinical cases, traineeship situation analysis, group work, room of errors, escape game, serious game, VR, mind map, conducting of audits). The questionnaire was only included in the analysis when this section was complete. A second section was comprised of optional questions relating to exam results during the 2020/2021 academic year. A final optional section contained questions on areas for improvement. The data collected was exported into an Excel table.

The analysis included a descriptive study providing information on the frequency at which each educational technique was

used, the resources used, and the results achieved on exams. The main criterion chosen to evaluate student success was the proportion of nursing students having passed the course unit compared to the number of students eligible for the exam, as a percentage. The impact of teaching on the average exam score was also evaluated. Factors predicting success were evaluated by univariate analysis, followed by a multivariate analysis taking account of the institute's status, its region, the number of nursing students enrolled in their 1st year of training in September 2020, the teacher's qualifications, the number of class hours attended, and the number of educational techniques used. Some variables were grouped together. Regions were grouped into 5 categories: Ile de France, South-West and Overseas France (Nouvelle Aquitaine, Occitania and Martinique, Guadeloupe, French Guiana, Reunion Island and Mayotte), South-East (Auvergne Rhône Alpes, Provence Alpes Côte d'Azur and Corsica), North-West (Brittany, Pays de la Loire, Centre Val De Loire and Normandy) and North-East (Bourgogne, Franche Comté, Grand Est and Hauts de France). The number of nursing students enrolled in their 1st year of training was divided into 2 groups based on the median number of students. Qualifications held by lecturers and teachers were divided into 2 categories: at least one academic versus no academics. One university teaching unit equalled one class taught by an academic or provided by the university under an agreement entered into by the nursing training institute and the university. The number of class hours was also divided into groups by calculating the median of the total number of L and T hours. The most innovative educational techniques were assessed individually: use of flipped classrooms, quizzes, serious games and non-procedural simulation, or not. The number of educational techniques used was divided into 2 groups based on the median number of techniques used. Qualitative variables were described in numbers or percentages. Quantitative variables were described using their average, standard deviation (sd) and minimum and maximum values, if of interest, or the median and interquartile range [Q1-Q3]. Variables were analysed using a Wilcoxon test or a Kruskal Wallis test. Variables with a univariate p.value <0.2 were included in a linear regression model. The variable expressing the number of educational techniques used was forced in the model. Results were expressed as an Odds Ratio (OR) at a Confidence Interval (CI) of 95% (CI95%). The significance threshold was set at 0.05. Statistical tests were carried out using Stata12 (StataCorp LP, College Station, TX, USA).

This study was qualified as research not involving human subjects (RIPH) based on research method MR-004.

Results

At the end of the survey period, 182 questionnaires were completed, 13 duplicates were excluded, thus providing 169 French nursing training institutes having responded to the questionnaire, i.e., a 52.8% return rate; 133 questionnaires were fully completed and 36 only partially. The return rate was similar regardless of the institute's status. The sample was comprised of 139 public establishments and 30 private non-profit establishments (Table 1). The various regions were represented (Figure 1.a) with a variable return rate according to region ranging from 28.6% (Bretagne) to 100% (Corsica) (Figure 1.b). The number of nursing students enrolled in their 1st year of training was on average 100 (sd=41.07); the median was 93

[65-127.5] (Table 1). The number of hours devoted to teaching the course unit was comprised on average of 19 hours and 34 minutes of lectures - ranging from 6 to 80 hours (sd=6.9), with a median of 20 [18-20] -, of 17 hours and 26 minutes of tutorials - ranging from 2 to 65 hours (sd=6.70), with a median of 18 [14-20] - and, lastly, of 7 hours 47 minutes of IGW - ranging from 0 to 50 hours (sd=5.54) with a median of 38 [4-10] - according to establishments. The median of the total number of lecture and tutorial hours was 38 hours [32-40] (Table 1). Lectures were mostly provided by academics or registered hygiene nurses (Figure 2a), while tutorials were mainly dispensed by course coordinators without any additional IPC qualifications (Figure 2b). Nurse training institutes called on lecturers and teachers with various qualifications to provide teaching: 25.44% called on only one type of lecturer and teacher, 33.14% called on two, 26.63% three, 12.42% four and 2.37% sought contributions from five different types of lecturers and teachers. Nurse training institution course coordinators providing such teaching widely volunteered to teach this course unit (59.76%), were rarely appointed by management (9.47%) but were sometimes both (24.26%). The resources used for teaching included recommendations issued by the French society for hospital hygiene (24.31%), the operational hygiene team (23.99%), the support centre for the prevention of healthcare-associated infections (23.34%), the World Health Organisation (14.26%) and the national nursing training institute document centre (14.10%). Nursing training institutes used several different resources.

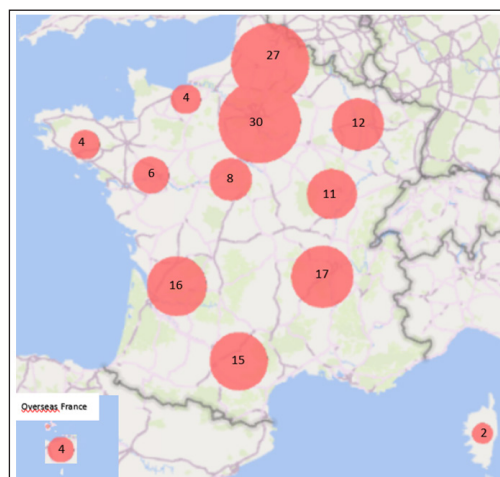


Figure 1a: Number of nursing training institutes per French region participating in the survey

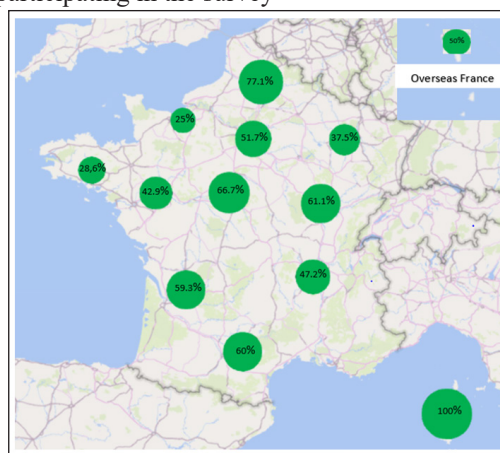


Figure 1b: Percentage of nursing training institutes participating in the survey per French region

Table 1: Characteristics of nursing training institutes participating in the survey

Variables	Total number of surveyed establishments (N = 169)	Number of establishments having provided a % of nursing students having passed the education unit (N = 140)	% of nursing students having passed the education unit	p value *	Number of establishments having provided an average exam score (N = 134)	Average exam score out of 20	p value *
Status, N (%)				0.596			0.212
Public	139 (82.25)	115 (82.14)	93.24			12.72	
Private	30 (17.75)	25 (17.86)	88.41			12.23	
Region, N (%)				0.069			<0.001
Auvergne Rhône Alpes	17 (10.10)	14 (10.00)	95.64		14 (10.45)	13.17	
Bourgogne-Franche-Comté	11 (6.51)	8 (5.71)	90.09		8 (5.97)	11.72	
Bretagne	4 (2.37)	3 (2.14)	97.31		3 (2.24)	15.58	
Centre-Val de Loire	8 (4.73)	5 (3.57)	97.19		3 (2.24)	13.78	
Corse	2 (1.18)	2 (1.43)	89.47		2 (1.49)	10.65	
Grand Est	12 (7.10)	9 (6.43)	92.52		6 (4.48)	10.99	
Hauts-de-France	27 (15.98)	22 (15.71)	85.83		22 (16.42)	11.26	
Île-de-France	30 (17.75)	23 (16.43)	91.83		23 (17.16)	12.40	

Normandie	4 (2.37)	3 (2.14)	91.70		3 (2.24)	13.84	
Nouvelle Aquitaine	16 (9.47)	16 (11.43)	95.49		15 (11.19)	12.30	
Occitanie	15 (.88)	14 (10.00)	87.08		14 (10.45)	12.37	
Outre-Mer	4 (2.37)	4 (2.86)	91.99		4 (2.99)	11.20	
Pays de la Loire	6 (3.55)	5 (3.57)	97.80		5 (3.73)	11.76	
Provence Alpes Côte d'Azur	13 (7.69)	12 (8.57)	96.06		12 (8.96)	13.45	
Number of nursing students, N (%)	N= 144						
Less than 50	9 (5.33)	8 (5.71)	91.74	0.063	8 (5.97)	12.15	0.120
Between 50 and 100	72 (42.60)	71 (50.71)	91.14		68 (50.75)	12.61	
Between 100 and 150	44 (26.04)	43 (30.71)	92.87		40 (29.85)	12.11	
Between 150 and 200	16 (9.47)	16 (11.43)	89.70		15 (11.19)	11.57	
More than 200	3 (1.78)	2 (1.43)	95.09		3 (2.24)	12.54	
Group 1 less than 93 nursing students	73 (50.69)	71 (50.71)	90.45	0.116	68 (50.75)	12.54	0.143
Group 2 less than 93 nursing students	71 (49.31)	69 (49.29)	92.41		66 (49.25)	12.09	
Number of Lectures and Tutorial hours							
Group 1 having benefitted from 38 or less hours of L and T	83 (49.11)	72 (51.43)	91.34	0.683	68 (51.13)	12.34	0.812
Group 2 having benefitted from over 38 hours of L and T	86 (50.89)	68 (48.57)	92.11		66 (49.25)	12.29	
Capacity of the teacher							
Academic	95 (56.21)	80 (57.14)	92.42	0.689	77 (57.46)	12.55	0.079
Non-academic	74 (43.79)	60 (42.86)	90.85		57 (42.54)	12	
Educational techniques							
Flipped classroom No	123 (72.78)	102 (72.86)	91.99	0.670	98 (73.13)	12.23	0.456
Flipped classroom Yes	46 (27.22)	38 (27.14)	91		36 (27.07)	12.57	
Quiz No	72 (42.60)	59 (42.14)	91.43	0.786	57 (42.54)	12.14	0.233
Quiz Yes	97 (57.40)	81 (57.86)	91.96		77 (57.46)	12.45	
Non-procedural simulation No	137 (81.07)	117 (83.57)	91.40	0.743	113 (84.33)	12.29	0.729
Non-procedural simulation Yes	32 (18.93)	23 (16.43)	93.40		21 (15.67)	12.44	
Serious game, escape game No	129 (76.33)	105 (75)	91.20	0.820	99 (73.88)	12.21	0.205
Serious game, escape game Yes	40 (23.67)	35 (25)	93.37		35 (26.12)	12.64	
Group 1 ≤ 8 different educational techniques	102 (60.36)	86 (61.43)	90.63	0.290	82 (61.19)	12.24	0.638
Group 2 > 8 different educational techniques	67 (39.64)	54 (38.57)	93.33	52 (38.81)		12.32	
Total			91.73			12.32	

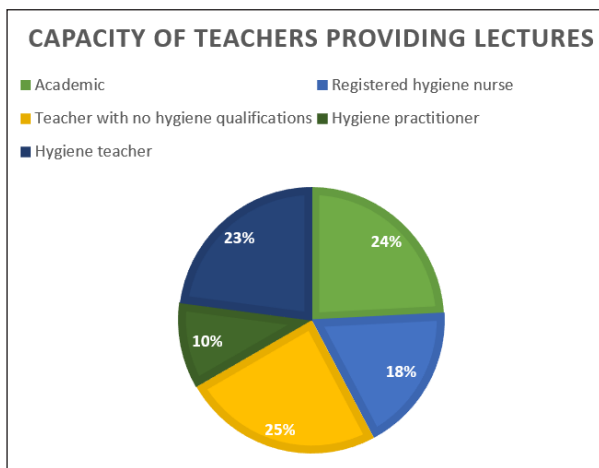


Figure 2a: Capacity of teachers providing lectures

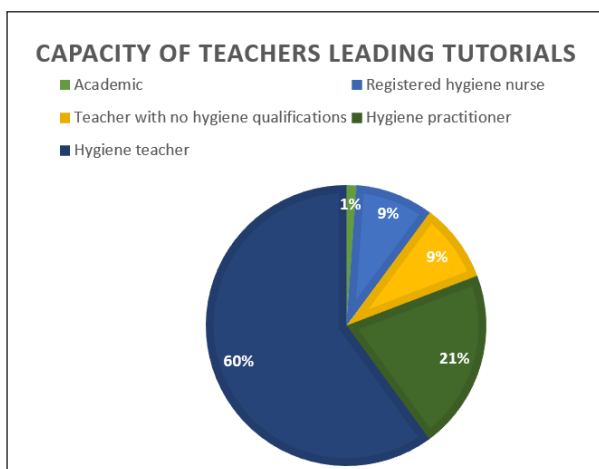


Figure 2b: Capacity of teachers providing tutorials

The educational methods applied were varied and several types were always combined (Figure 3). The median number of different educational techniques used was 8 [6-10]. The two educational methods most used were lectures involving a speaker and use of UV lamps. Evaluation methods differed according to establishment and sometimes combined: 75.74% of nursing training institutes asked students to analyse a situation encountered during a traineeship, 26.04% required them to analyse a situation developed by the course coordinator and 24.26% required a knowledge assessment test. For the second section of the survey, 29 questionnaires did not allow the calculation of an exam success rate due to missing data. Thus, 140 success percentages were available for each establishment (i.e., 43.8% of nurse training institutes in France). 91.73% of nursing students passed the course unit at the end of their 1st year of training. The exam success rate was significantly linked to the North-West region (OR=1.060, IC95% [1.006-1.117] and to a number of students higher than 93 (OR=1.034, CI95% [1.004-1.065]) adjusted by the number of educational techniques used (Table 2). 134 establishments (41.9% of nursing training institutes in France) provided data on average exam scores. The average score achieved on exams was 12.32 out of 20, ranging from 8 to 18 (sd=1.69) (Table 1). This score was significantly associated with the South-East (OR=2.470, CI95% [1.103-5.532]) and North-West (OR=3.761, CI95% [1.401-10, 097]) regions and conversely associated with the North-East region (OR=0.444, CI95% [0.205-0.962]) adjusted based on the number of nursing students enrolled in their 1st year, the teacher's

qualifications and the number of educational techniques used (data not presented) [22].

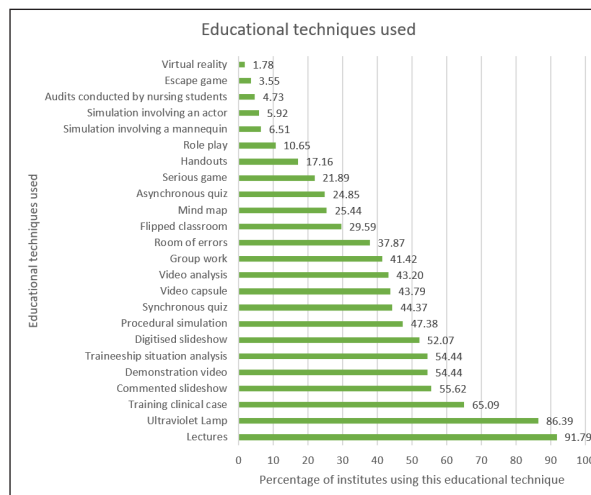


Figure 3: Educational techniques used

Table 2: Factors influencing course unit success

	OR	[CI95%]	p value*
Regions Sud-Ouest and Outre-Mer	1		
Ile de France	0.987	[0.942-1.034]	0.587
Sud-Est	1.040	[0.995-1.087]	0.078
Nord-Ouest	1.060	[1.006-1.117]	0.028
Nord-Est	0.968	[0.930-1.009]	0.124
Number of nursing students			
Less than 92 nursing students	1	[1.004-1.065]	0.029
Over 93 nursing students	1.023		
Number of educational techniques			
≤ 8	1		0.139
> 8	1.023	[0.993-1.054]	

CI = Confidence interval; OR = Odds Ratio*

Discussion

Participation among nursing training institutes was high, demonstrating course coordinators' interest in this topic. The exam success rate was highly satisfactory but the average score achieved on the exam was not very high. There were significant differences in the number of classes dispensed and the educational techniques applied as well as in the assessment methods used. Factors predicting success on the IPC knowledge assessment included the North-West region and a class comprised of more than 93 nursing students.

The study was conducted based on the first semester of the 2020-2021 academic year. During this period, SARS-CoV-2 was very active in France. Higher education was disrupted by the second lockdown, with many classes being held online due to a limited number of students being permitted to enter auditoriums, cutting the number of students physically attending classes by

half. Course coordinators and nursing students were not familiar with this type of educational method. E-learning requires very well-designed and well-structured classes [23]. Such teaching conditions may have had an impact on the quality of the classes dispensed and on exam results. However, this period was also beneficial in terms of increased awareness among nursing students regarding the need to comply with IPC rules during traineeships to prevent possible contamination.

The percentage of success for IPC exams is very high at the end of the 1st year of training. When this course unit is failed, nursing students may move on to the next year provided they have acquired at least 48 European credits (ECTS: European Credits Transfer System) out of 60 and must take the exam again during their second year of training. In 2015, over 83% of nursing students in their 1st year received their diploma 3 years later [24]. Success rates in this pathway are high, which may explain the high success percentage for IPC exams.

The average exam score was not very high, confirming the data found in literature identifying average knowledge [25-29]. Thus, IPC teaching methods should be reviewed to improve nursing student knowledge. Theoretical contributions must necessarily be remobilized during the rest of training and during traineeships to enable nursing students to further their knowledge.

The assessment methods used varied, with most establishments asking nursing students to analyse a situation encountered during their traineeship, as required by the training framework. Several establishments appear to have deemed this assessment method insufficient and have combined or replaced it with a knowledge assessment method. Analyses are difficult exercises for nursing students at the start of their training and do not always provide insight into whether the student has mastered essential knowledge.

The number of class hours provided varied widely according to establishment and the median was less than the number of class hours recommended by the training framework. This could be because the total number of hours recommended for all course units cannot mathematically be achieved due to a discrepancy between legal recommendations and the calendar. Nonetheless, in our study, the number of class hours did not significantly improve nursing students' results on exams, matching the research carried out by Ward, but contradicting that conducted by Carter [30,31]. Carter evaluated IPC knowledge among American nursing students. He found that the number of course hours was significantly related to reported observance of IPC by nursing students. Ward, however, conducted a literature review of the role played by education in HAI prevention among nursing students and midwives. This study concluded that there was no evidence to support that the number of hours improved compliance with HAI prevention measures.

Classes were provided by lecturers and teachers with varying qualifications. Most lectures were provided by teachers with IPC qualifications, while such was not the case for tutorials. The national action plan for the prevention of healthcare-associated infections recommends that nurses' IPC training be dispensed first and foremost by professionals specialising in IPC [32].

The educational techniques used varied significantly and all establishments applied more than one. We hypothesised that the number of educational techniques could have an impact on the results of the students. Lectures involving a speaker and handwashing with UV lamps were the methods most used. These educational methods were highly conventional. Today, more innovative educational methods are used such as flipped classrooms, educational games, simulation and VR. A few establishments used these educational methods, but they are still few and far between. Flipped classrooms were offered by less than one-third of nursing training institutes. Although our study was not designed for this purpose, we were not able to demonstrate that this educational technique improved results, unlike other studies carried out across the world which have proven the effectiveness of flipped classrooms in nursing training. Two literature reviews showed that the use of flipped classrooms in nursing training improved exam results and learning quality [20,33]. The nursing training framework encourages the use of simulation as an active and innovative educational method based on experiential learning and reflective practice. In our study, hand hygiene procedure simulation using UV lamps was widely used, while non-procedure simulation was rarely used. A study conducted in France in 2019 in simulation centres and healthcare profession training centres showed that few scenarios aimed to prevent infectious risks [34]. IPC was never the main objective of a simulation session. If infectious risk prevention is considered of secondary importance by the training environment, attracting interest from professionals will prove difficult. Various types of simulation have proven to be effective as has VR, yet, this technique is used in less than 2% of surveyed nursing training institutes [35-38]. In our study, we were not able to demonstrate that use of educational games improves nursing students' results. A literature review showed that school performance was better or unchanged when gamification was applied to healthcare professional training, but few of these studies included control groups [39]. Nursing students appreciate this method which increases their motivation to learn but the improvement of their knowledge has either not been measured or is based on insufficient studies [40,41].

We analysed the regional factor because university education is standardized in some regions. The regional factor we identified should be analysed with care due to multiple possible biases. We did not encounter this factor when considering Bachelor exam success. The North-West region, which appears to show the best results, has education unit assessment conditions that are slightly different from the nationally representative sample. Nursing training institutes in this region require traineeship situation analyses, as provided for in the training framework, and few nursing training institutes carry out knowledge assessment. Knowledge assessment or practice assessment tests at national level could confirm or deny the significance of region of origin.

Nursing students from classes with over 93 nursing students also achieve better exam success. We can assume that establishments with a high number of nursing students are most likely tied to a university hospital centre and that these establishments benefit from a better training and traineeship support culture as well as better partnerships between the nursing training institute and the relevant hospital establishment.

Our study did have some limits. The survey was conducted during the COVID-19 health crisis, which may have changed course coordinators' practices as well as students' awareness. We cannot exclude that the nursing training institutes having participated in the survey may have been those most sensitive to the topic. However, we were able to include over half of all nursing training institutes in all French regions. The survey was conducted using a self-administered questionnaire that may not mirror the reality of what occurs inside establishments. Lastly, our survey compared results from various assessments; content and expectations may vary from one establishment to another, but the threshold for success in each is always 10 out of 20.

Conclusion

Our study has shown the various educational practices used to teach IPC in nursing training. Teaching methods, resources and assessment methods vary, despite a common national regulatory framework. Scores reflecting knowledge acquired during the first year of training are average in most establishments. A common knowledge assessment for all nursing students in all nursing training institutes could allow for a comparison to be made. Increased partnerships with traineeship locations and operational hygiene teams would be of interest. Nursing students must also be able to use such knowledge in their subsequent training. The Infectiology and IPC education unit could be a transversal unit spanning all 3 years of training and could be included in various skills in a more formalised manner. In order to cement essential IPC notions, it would be interesting to review the educational methods offered and to modernise these to adapt to the new generation. Random controlled tests are needed to measure the effectiveness of educational methods on nursing students' knowledge and practices.

Conflict of Interest: None

Funding Sources: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Statements: This study was qualified as research not involving human subjects (RIPH) based on research method MR-004.

Data Availability Statement: Data are available on reasonable request.

Credit Authorship Contribution Statement: SBM and CL conceptualized and designed the study. Statistical analysis was carried out by CD. SBM and CL analyzed and interpreted the data. SBM and CL drafted the manuscript. SBM, CD and CL approved the final version of the manuscript.

References

- INSERM. Insemm. Infections nosocomiales, « HAIs ». Disponible. 2021. <https://www.inserm.fr/information-ensante/dossiers-information/infections-nosocomiales>
- SFHH, Actualisation des précautions standard, « Updating of standard precautions », 2017. Disponible. https://sf2h.net/wp-content/uploads/2017/06/HY_XXV_PS_versionSF2H.pdf
- Arrete du 31 juillet 2009, « French Order of 31 July 2009 » Disponible 2009 https://solidarites-sante.gouv.fr/IMG/pdf/arrete_du_31_juillet_2009.pdf
- Bouget Mohammadi S, Landelle C. Review of literature: Knowledge and practice of standard precautions by nursing student and teaching techniques used in training. *American Journal of Infection Control*. 2023. 51: 574-581.
- Al-Hussami M, Darawad M. Compliance of nursing students with infection prevention precautions: effectiveness of a teaching program. *Am J Infect Control*. 2013. 41: 332-336.
- Goyal M, Chaudhry D. Impact of Educational and Training Programs on Knowledge of Healthcare Students Regarding Nosocomial Infections, Standard Precautions and Hand Hygiene: A Study at Tertiary Care Hospital. *Indian J Crit Care Med*. 2019. 23: 227-231.
- Kısacık ÖG, Çiğerci Y, Güneş Ü. Impact of the fluorescent concretization intervention on effectiveness of hand hygiene in nursing students: A randomized controlled study. *Nurse Educ Today*. 2021. 97: 104719.
- Ott LK, Irani VR. Evaluating the effectiveness of real-time feedback on the bedside hand hygiene behaviors of nursing students. *J Nurs Educ*. 2015. 54: 286-289.
- Kim E, Kim SS, Kim S. Effects of Infection Control Education for Nursing Students Using Standardized Patients vs. Peer Role-Play. *Int J Environ Res Public Health*. 2020. 18.
- Wu KS, Lee SSJ, Chen JK, Chen YS, Tsai HC, et al. Identifying heterogeneity in the Hawthorne effect on hand hygiene observation: a cohort study of overtly and covertly observed results. *BMC Infect Dis*. 2018.18: 369.
- Dembilio-Villar T, González-Chordá VM, Cervera-Gasch Á, Mena-Tudela D. Cooperative Learning and Hand Disinfection in Nursing Students. *Invest Educ Enferm*. 2018. 36.
- Wagner PD, Parker JC, Mavis EB, Smith MK. An Interdisciplinary Infection Control Education Intervention: Necessary But Not Sufficient. *Journal of Graduate Medical Education*. 2011. 3: 203-210.
- Salmon S, Wang XB, Seetoh T, Lee SY, Fisher DA. A novel approach to improve hand hygiene compliance of student nurses. *Antimicrob Resist Infect Control*. 2013. 2: 16.
- Whitcomb KS. Using a multidimensional approach to improve quality related to students' hand hygiene practice. *Nurse Educ*. 2014. 39: 269-273.
- Xiong P, Zhang J, Wang X, Wu TL, Hall BJ. Effects of a mixed media education intervention program on increasing knowledge, attitude, and compliance with standard precautions among nursing students: A randomized controlled trial. *Am J Infect Control*. 2017. 45: 389-395.
- Hassan ZM. Improving knowledge and compliance with infection control Standard Precautions among undergraduate nursing students in Jordan. *Am J Infect Control*. 2018. 46: 297-302.
- Kappes Ramirez MS. Influence of undergraduate nursing student teaching methods on learning standard precautions and transmission-based precautions: Experimental research. *Nurse Educ Today*. 2018. 61: 101-105.
- Korhonen A, Vuori A, Lukkari A, Laitinen A, Perälä M, et al. Increasing nursing students' knowledge of evidence-based hand-hygiene: A quasi-experimental study. *Nurse Educ Pract*. 2019. 35: 104-110.

19. Pangandaman HK, Boloron RP, Lambayong JH, Ergas ML, Raki-in RM, et al. Innovative classroom pedagogy In nursing education: A systematic review. *International Journal of Health Medicine and Current Research*. 2019. 4: 1543-1549.
20. Özbay Ö, Çınar S. Effectiveness of flipped classroom teaching models in nursing education: A systematic review. *Nurse Education Today*. 2021. 102: 104922.
21. DREES. La formation aux professions de santé, « Health professions training » 2021. https://data.drees.solidarites-sante.gouv.fr/explore/dataset/491_la-formation-aux-professions-de-sante/
22. Décret du 2020. « French Order of 29 October 2020 ». 2020-1310 2020.
23. Amadiou F, Tricot A. Apprendre avec le numérique, « Learning with digital technology ». Nouvelle éd. Paris: Retz. (Mythes et réalités). 2020.
24. Croguennec Y. La formation aux professions de la santé en 2015. 2015. 156.
25. Cruz JP, Bashtawi MA. Predictors of hand hygiene practice among Saudi nursing students: A cross-sectional self-reported study. *J Infect Public Health*. 2016. 9: 485-493.
26. Karadag M, Pekin Iseri O, Yildirim N, Etikan I. Knowledge, Beliefs and Practices of Nurses and Nursing Students for Hand Hygiene. *Jundishapur J Health Sci*. 2016. 8: <https://sites.kowsarpub.com/jjhs/articles/15069.html>
27. Tem C, Kong C, Him N, Sann N, Chang SB, et al. Hand hygiene of nursing and midwifery students in Cambodia. *Int Nurs Rev*. 2019. 66: 523-529.
28. Thakker VS, Jadhav PR. Knowledge of hand hygiene in undergraduate medical, dental, and nursing students: A cross-sectional survey. *J Family Med Prim Care*. 2015. 4: 582-586.
29. Zimmerman PAP, Sladdin I, Shaban RZ, Gilbert J, Brown L. Factors influencing hand hygiene practice of nursing students: A descriptive, mixed-methods study. *Nurse Educ Pract*. 2020. 44: 102746.
30. Ward DJ. The role of education in the prevention and control of infection: A review of the literature. *Nurse Education Today*. 2011. 31: 9-17.
31. Carter EJ, Mancino D, Hessels AJ, Kelly AM, Larson EL. Reported hours of infection education received positively associated with student nurses' ability to comply with infection prevention practices: Results from a nationwide survey. *Nurse Education Today*. 2017. 53: 19-25.
32. Programme national de prévention des infections associées aux soins, "National program for the prevention of HAIs", 2015. <https://solidarites-sante.gouv.fr/IMG/pdf/propiasjuin2015.pdf>
33. Lelean H, Edwards F. The impact of flipped classrooms in nurse education. *WJE*. 2020. 25: 145-157.
34. Vergnes H, Couarraze S, Decormeille G, Boudot E, Delannoy V, et al. Risque infectieux et simulation en santé. 2021.
35. Kim J, Park JH, Shin S. Effectiveness of simulation-based nursing education depending on fidelity: a meta-analysis. *BMC Med Educ*. 2016. 16: 152.
36. Chen FQ, Leng YF, Ge JF, Wang DW, Li C, et al. Effectiveness of Virtual Reality in Nursing Education: Meta-Analysis. *J Med Internet Res*. 2020. 22: e18290.
37. Foronda CL, Fernandez-Burgos M, Nadeau C, Kelley CN, Henry MN. Virtual Simulation in Nursing Education: A Systematic Review Spanning 1996 to 2018. *Sim Healthcare*. 2020. 15: 46-54.
38. Saab MM, Hegarty J, Murphy D, Landers M. Incorporating virtual reality in nurse education: A qualitative study of nursing students' perspectives. *Nurse Educ Today*. 2021. 105: 105045.
39. Van Gaalen AEJ, Brouwer J, Schönrock-Adema J, Bouwkamp-Timmer T, Jaarsma ADC, et al. Gamification of health professions education: a systematic review. *Adv in Health Sci Educ*. 2021. 26: 683-711.
40. Anguas-Gracia A, Subirón-Valera AB, Antón-Solanas I, Rodríguez-Roca B, Satústegui-Dordá PJ, et al. An evaluation of undergraduate student nurses' gameful experience while playing an escape room game as part of a community health nursing course. *Nurse Education Today*. 2021. 103: 104948.
41. Sardi L, Idri A, Fernández-Alemán JL. A systematic review of gamification in e-Health. *Journal of Biomedical Informatics*. 2017. 71: 31-48.
42. INSEE. « Successful completion of the bachelor », Réussite au baccalauréat-2019. <https://www.insee.fr/fr/statistiques/2012792>