Research on the Construction of "1 + X" System for Vocational Undergraduates of Navigation Technology Major

Descriptive Analysis of Big Data Based on Enrollment, Recruitment, Examination, Supply and Demand of Chinese Seamen

Aimin Wei and Hui Wang(✉)

Maritime School of Hainan Vocational University of Science and Technology, Haikou, China
juliawanghui@163.com

Abstract. Under the epidemic, the shipping market gradually returned to normal after a round of rapid expansion. The seafarer education/training market is booming with the rapid expansion of the shipping market. The seafarer education and training market fluctuates with the fluctuation of the shipping market. Nowadays, it is necessary to study how China's seafarer market develops and how it develops rationally.

This paper revealed the present situation of supply and demand of the seafarer market under the epidemic situation with a descriptive analysis of big data from marine authorities. The research finds that there is a structural shortage in the seafarer market, and a risk of actual shortage exists. Based on the analysis of the national vocational education 1 + x system policy, the research puts forward that the seafarer education and training organizations should combine the training of various sailor grades' competency certificates and the market demand to systematically formulate the personnel training target system. This study provides a scientific reference for formulating the education and training objectives of Chinese sailors. It is beneficial to promote the seafarer market to maintain a sustainable and reasonable structure and healthy development.

Keywords: 1 + x system · major in navigation technology · academic certificate · professional certificate

1 Preface

On January 24, 2019, The State Council issued the Implementation Plan of the National Vocational Education Reform, which points out that vocational education and general education is two different types of education with equal importance. Starting from 2019, the pilot work of "educational certificate + certificates of several vocational skill levels" system (hereinafter referred to as 1 + x certificate system) shall be launched in vocational colleges and application-oriented undergraduate universities. In 2019, the Ministry of Education jointly issued the 1 + x plan with the National Development and

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Reform Commission, the Ministry of Finance and the State Administration for Market Regulation [1]. China's nautical vocational education can be traced back to 1815, but the long history of nautical education has not made the road of later education brilliant. At present, China's nautical personnel in the global nautical market in the quality ranking and word of mouth (reputation), apparently behind those from India, the Philippine and other countries with a lower level of economic development. This has to let us re-examine the current situation of our nautical education. The students in navigation major shall be cultivated according to the requirements of STCW Convention at school, accepting professional skill training at the same time. Then they have to pass the certificate examinations and professional skill assessment before they could obtain the competency certificate and several skill certificates necessary for the post on board.

This paper uses descriptive analysis with the Big Data on the Supply and Demand of Chinese Seafarers jointly released by Shanghai Maritime University, Shanghai Maritime Safety Administration (MSA) and Shanghai Shipping Exchange (SSE) 2021 [2]. It indicated that by the end of 2020, China had 1,716,866 registered sailors, ~~up~~ with 3.5 percent elevation year on year, among whom 258,896 were women. The sum of seagoing crew was 808,183, up by 3.0% year on year; the number of inland waterway vessels was 908,683, up 3.9 percent year on year. In 2020, there were 377,638 seamen with seaborne service qualifications, accounting for 46.7% of the total seaborne crew. In 2020, due to the COVID-19 epidemic, the data of crew development fluctuated compared with the past. China's seafarers are in short supply. Due to the impact of COVID-19 and other factors, CSSDI reveals the overall supply and demand of Chinese seafarers in 2020 has changed significantly from that in 2019, with a decrease of 9.63% and an overall shortage of 4.2% [3]. The relationship between the supply and demand of seafarers is changing from structural differentiation to absolutely shortage: although the supply and demand of seafarers in different navigation areas and different positions are still differentiated, if not regulated, there may be a systematic shortage of seafarers. Please refer to Fig. 1 and 2.

	4th Engineer	oiler	3rd officer	AB	Engine	2nd officer	Master	chief engineer	2nd engineer	chief officer
2019	121.09	134.55	118.34	126.41	141.14	134.69	112.71	111.69	146.72	140.34
2020	84.58	107.26	92.69	102.21	121.7	121.01	101.67	102.42	141.41	144.98
change rate	-36.51	-27.29	-25.65	-24.2	-19.44	-13.68	-11.04	-9.27	-5.31	4.64

Fig. 1. Comparison of the supply and demand of seafarers worldwide 2020 and 2019

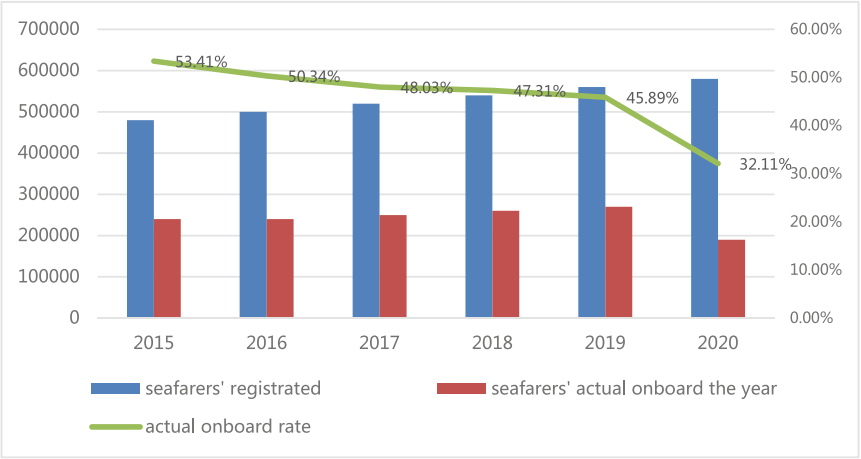

Fig. 2. Schematic diagram of the seafarers' registration and actual ship status in 2015–2020

The relationship between supply and demand of seafarers in international navigation area has changed obviously. In 2020, the supply and demand of seafarers in international navigation areas showed drastic changes compared with the previous year, with a decrease of 19.12%. For the first time in recent years, the number of Chinese seafarers sent abroad dropped by 21.3%. The annual number and proportion of active seafarers with service qualifications in the international navigation area accelerated to decline, from 264,242 to 190,422 by 32.11%. [4]. The third officer, third engineer, sailor, oiler and other positions are in short supply, and the structure of the supply and demand relationship are unreasonable. Please refer to Fig. 3.

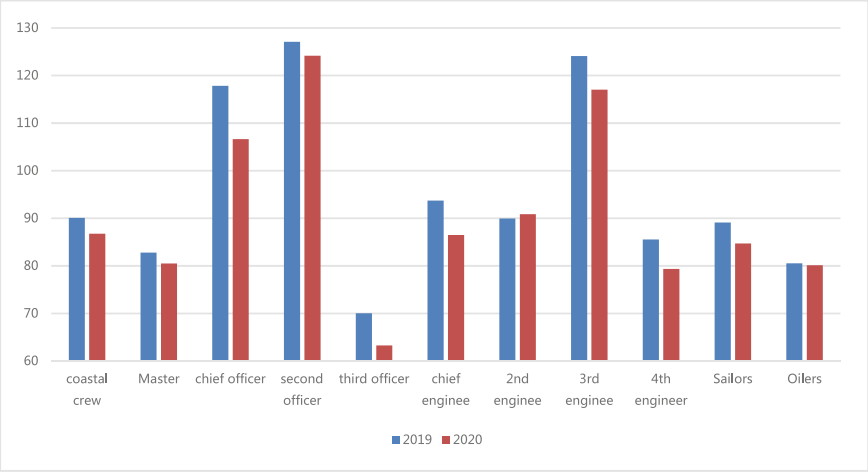

Fig. 3. Comparison of the supply and demand of seafarers in coastal areas in 2020 and 2019

The Big data analysis on the enrollment plans and actual enrollment data of navigation majors at all levels in China in the past five years found that the enrollment plans and actual enrollment numbers of undergraduate students remained stable in the past five years. College enrollment plan and the actual number of students increased year by year; Technical secondary school enrollment plan and the actual number of enrollment is less [5]. See Table 1. Undergraduate enrollment register rate is higher, junior college enrollment register rate is obviously low, vocational school enrollment register rate is very low. The enrollment plan registration rate is not high, indicating that there are some difficulties in the enrollment statistics of relevant majors, as shown in Table 1 and 2 and Fig. 4.

According to the requirements of the current examination and certification rules of the National Maritime Administration, graduates must pass the qualification examination before they can go on board for probation. Without exception, all these graduates choose to take the certificate of operation-class sailor to get employment, so the number of graduates who actually works on the ship is lower than that of those who take the examination [8] (see Table 3). Thus, the shortage of supply and demand of the crew is further aggravated, and the structural irrationality of supply and demand of the crew is aggravated.

With the outbreak of COVID-19, the international demand and supply of seafarers changed dramatically, and varied greatly in different navigation areas and positions. If not regulated, there would be a systemic shortage of seafarers, which should be paid enough attention to by policy makers, shipping and academic circles. Therefore, it is urgent to actively implement the national vocational education policy and construct a reasonable and feasible 1 + x system for navigation major [10].

Vocational education and general education are two different types of education with equal importance, according to a circular issued by The State Council in 2019 on the Implementation Plan of the National Vocational Education Reform. With vocational education in China entering the new development stage, national industrial upgrading and economic structure adjustment constantly accelerates, all walks of life have more and more urgent demand for personnel with technical skills, so the important position and role of vocational education become more and more prominent. Since 2019, the pilot work of the "educational certificate + certificates of several vocational skill levels" system (hereinafter referred to as the 1 + x certificate system pilot) has been launched in vocational colleges and application-oriented undergraduate universities [6]. In the 1 + x certificate system, "1" refers to the certificate of academic qualification, which refers to the diploma obtained by the learner after completing the learning task of the education stage in the school or other education institution that implements academic qualification education in the school system. While "X" refers to a number of vocational skill level certificates [7].

In the implementation of "1 + x certificate system", it is undoubtedly necessary to understand the relationship between educational certificate "1" and vocational skill level certificate "X". The purpose of implementing the 1 + x certificate system is to encourage students to receive vocational education to obtain certificates of various vocational skills, but this is by no means to reduce the requirements for academic certificates [9]. Academic certificate is the basic condition for students to graduate, and it is also the basis

Table 1. Enrollment plans and actual enrollment amount of Marine specialties in China from 2016 to 2020

Enrollment level	Major	2016		2017		2018		2019		2020	
		enrollment	admissions	enrollment	admissions	enrollment	admissions	enrollment	admissions	enrollment	admissions
under graduate	navigation	2869	2688	2724	2563	2761	2706	2855	2793	2773	2717
	engine	2753	2685	2706	2632	2771	2725	2854	2773	2588	2533
	electronic	662	648	753	732	793	773	797	766	883	854
	Sub ttl	6284	6021	6183	5927	6325	6204	6506	6332	6244	6104
junior college	navigation	6301	4748	6195	4570	6728	5324	7594	6176	7449	6183
	engine	4846	2752	2052	2712	5165	3148	5761	3497	3008	4082
	electronic	1055	742	1059	610	1003	638	1427	971	1566	1194
	Sub ttl	12202	8242	12306	7892	1296	9110	14782	10644	15023	11459
technical school	navigation	1000	419	1040	419	920	400	1017	549	760	472
	engine	890	224	890	151	850	196	840	285	620	229
	electronic	80	3	80	0	80	13	80	12	80	20
	Sub ttl	1970	646	2010	570	1850	609	1937	846	1460	721
Total		20456	14909	20499	14389	21071	15923	23225	17822	22727	18284

Table 2. Enrollment rate of navigation majors from 2016 to 2020

Enrollment level	Major	Enrollment rate of navigation maiors				
		2016	2017	2018	2019	2020
under graduate	navigation	93.69	94.09	98.01	97.83	97.98
	engine	97.53	97.27	98.34	97.16	97.87
	electronic	97.89	97.21	97.48	96.11	96.72
	Sub ttl	95.81	95.86	98.09	97.33	97.76
junior college	navigation	75.35	73.77	79.13	81.33	83.00
	engine	56.79	132.16	60.95	60.70	135.70
	electronic	70.33	57.60	63.61	68.04	76.25
	Sub ttl	67.55	64.13	702.93	72.01	76.28
technical school	navigation	41.90	40.29	43.48	53.98	62.11
	engine	25.17	16.97	23.06	33.93	36.94
	Sub ttl	3.75	0.00	16.25	15.00	25.00
Total		32.79	28.36	32.92	43.68	49.38

for students to enter higher level study. Vocational education is firstly academic education, and secondly it has the characteristics of vocational training. Academic education is a systematic, scientific and standardized form of education. For personnel training, academic education and vocational skills training complement each other.

Nautical education in China has always been using the "education + training + certificate" method, some training institutions even directly adopt the "training + certificate" method, the final result is the need for students to obtain the appropriate competence certificate of the crew member, then work on the ship. Therefore, there are two extreme phenomena in navigation education. One is to emphasize the passing rate of training and the certificate examination, and the other is to emphasize that students have enough theoretical knowledge to further their studies without compulsory certificate examination. Then, as an undergraduate navigation technology major in vocational education, how should we understand the connotation of "1" and "X" and the logical relationship between them under the "1 + x" system?

This PAPER TRIES to clarify this problem according to the national teaching standards for general undergraduate majors, the national teaching standards for higher vocational education majors, the national vocational code, the industry standards and the orientation of vocational undergraduate education, so as to provide a reference for the development of vocational undergraduate nautical technology majors in China.

Table 3. The number of crew and passing rate of Te exam from 2016 to 2020 of the operation-level

Enrollment level	Major	2016		2017		2018		2019		2020	
		admissions	passing rate	admissions	passing rate	admissions	passing rate	admissions	passing rate	admissions	passing rate
Under graduate	navigation	1272	56.36	1020	45.09	1038	44.72	999	42.15	858	34.29
	engine	1070	47.32	878	38.78	827	34.73	808	34.31	464	18.91
	electronic	221	34.24	90	43.38	214	42.97	197	39.72	125	21.11
	Sub ttl	2563	49.64	2088	42.06	2079	39.98	2004	38.38	1447	26.08
junior college	navigation	1330	27.08	1273	26.93	1168	24.89	1095	25.47	0	21.83
	engine	865	26.15	822	27.7	756	26.3	686	26.59	929	19.65
	electronic	153	29.03	150	29.24	140	25.09	133	20.94	512	19.69
	Sub ttl	2348	26.84	2245	27.35	2064	25.4	1914	25.47	1566	20.89
technical secondary school	navigation	49	7.54	55	12.2	82	19.9	81	17.34	58	16.11
	engine	21	5.95	27	10.76	64	31.02	67	28.76	32	20.92
	Sub ttl	70	6.82	82	11.42	149	23.32	148	21.14	90	17.24
		4981	33.35	4415	31.79	4292	30.74	4066	30.26	3103	22.88

Table 4. Connotation of "1 + X" in Marine technology major

1	Career oriented	X Skills	X grade	Corresponding position (group)
Bachelor Degree in Navigation Technology	Water Transport Service 04–02-03	Basic training certificate	elementary	non-navigation duty support class
	Command and Pilot (2–04-02)	AB's certificate	middle rank	navigation duty support class
	Command and Pilot (2–04-02)	3/0 $_{or}$ radio officer	senior	navigation duty -operation class

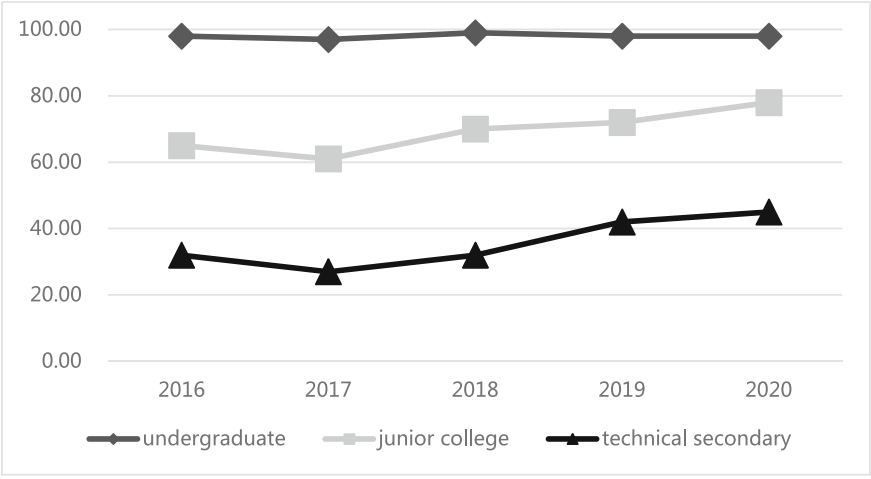

Fig. 4. Enrollment rate of navigation majors at all levels in China from 2016 to 2020

2 What is the "1" of Nautical Technology Major

The "1" of Marine technology major is the certificate of academic qualification. What standards do the CERTIFICATE OF diploma OF THIS MAJOR undergraduate course needs to satisfy? Navigation technology belongs to the major category of transportation. The National GENERAL UNDERGRADUATE MAJOR CLASS TEACHING QUALITY STANDARD TRANSPORTATION MAJOR REQUIREMENTS are: THE total professional credits are generally required to be 140 ~ 180 CREDITS, among which the practise credits are not less than 25% of the total credits. The professional curriculum system is set up in three categories: general education, subject foundation and specialty. General education courses in the humanities and social sciences should account for at least 15%, mathematics and natural sciences courses for at least 15%, and basic and professional courses other than mathematics and natural sciences courses for at least 40% of the total credit, respectively.

The core knowledge areas of Maritime technology major mainly include the ship navigation and positioning, the ship structure and equipment, Marine communication, ship maneuvering and collision avoidance, ship navigation and information systems, shipping freight, Marine meteorology and oceanography, ship management, and maritime English, etc. Various universities can make appropriate adjustments according to the specific situation of running [11]. The specific name, teaching content, teaching requirements, corresponding class hours, credit and other arrangements of the course are determined by each university independently. The university also sets some relevant elective courses reflecting the characteristics of the university, region or industry [12]. If a student takes the relevant courses above and passes the grades, it means that he has completed the required tasks of the major, and he can get the graduation certificate of the major, which is called "academic certificate".

3 What Are the "X" of Maritime Technology Major

"X" in mathematics usually refers to a variable. But in the context of vocational education, it takes on a much richer meaning: variable not only in quantity but also in rank. However, if it is put together with "1", it will be restricted by "1". The connotation of "X" should be associated with "1", that is to say, "X" should be the certificate required by the professional position of "1" [13].

In addition, the vocational skill training of x certificate is not to design a set of training system and the curriculum system independently of academic teaching, but to organically integrate its training content into the professional talent training program of academic education. If the curriculum of academic education can cover the content of x certificate vocational skills training, x certificate training will not be set up separately; for the training content not covered by academic courses, it is then strengthened and expanded through vocational skills training modules. The training process of "X" certificate and the teaching process of diploma education is thus coordinated, organized and implemented simultaneously. Since the training content of x certificate is organically integrated with the professional courses of academic education, the "x" certificate training and educational can arrange the teaching content, the practice place, organization form, teaching time and teachers, so as to realize the integration of x certificate training and educational teaching process x "certificate vocational skills assessment and academic education professional course examination arrangement, with simultaneous examination and evaluation. The correspondence between vocational skill level standards and educational standards, the integration of x certificate training content and educational courses, and the overall arrangement of training process and educational process lay a foundation for the overall arrangement and simultaneous examination evaluation of x certificate vocational skill assessment and educational background professional course examination.

According to the national teaching standards of navigation technology major in national higher vocational schools, the vocational orientation of navigation technology major is ship commanding and ship piloting (2–04-02) and water transport service personnel (04-02-03). Therefore, the "X" of navigation technology major should correspond to the certificates required by the above two "oriented" vocational posts.

How to set x for nautical technology major? It requires comprehensive career planning, targeted selection of vocational skill level certificates, and timely adjustment of learning focus.

According to the Rules of the People's Republic of China for Examination and Certification of Seafarers, the DUTIES of seafarers are divided into: (1) Seafarers who takes part in navigation and the engine-watch and (2) Seafarers who do not take part in navigation and the engine watch, namely, water transport service personnel. In the case of nautical graduates, crew members participating in navigation and turbine watches include 1.Captain; 2. Deck crew: first mate, second mate, third mate, senior duty-officer and duty officer, among which the first mate, second mate and third mate are collectively referred to as pilots; 3. Radio Operators: Radio Electronic Operator I, Radio Electronic Operator II, Universal Radio Operator, Restricted Radio Operator. If one has not obtained the above post certificate, one can be engaged in the crew not participating in navigation and engine duty, namely, water transport service personnel.

Therefore, the vocational qualification certificate of students majoring in maritime technology can be selected as: (1) They can obtain basic safety training (X1) for seafarers. By meeting the age and physical examination conditions, they can be engaged in seafarers who do not participate in navigation and engine watch, namely, water transport service personnel, and become seafarers who do not participate in navigation watch support; (2) On the basis of X1, sailors who pass the training and the examination X2 can be on board the ship to participate in the navigation watch and become the support class of the navigation watch; (3) On the basis of X2, trainees shall take part in the third mate fitness training and obtain the certificate, and be the third mate participating in the navigation watch, and become the operation-level seaman participating in the navigation watch, as shown in the following Table 4.

Such 1 + x, 1 is the certificate of nautical technical education; corresponds to the skills or qualifications required by the profession of nautical technology major. Academic education and vocational skill training complement each other. The former is the foundation, while the latter highlights the improvement of vocational skills on the basis of the former, and the latter plays a role in promoting the teaching reform of the former.

4 "Course and Certificate Integration" of Navigation Technology Major

The essence of the "1 + x certificate system" is the mutual connection and integration of academic education and vocational skill training. The vocational skill level standards and the education standards of all levels are connected with each other. This connection is determined by the relationship between the educational certificate and vocational skill level certificate. Vocational skill standards of different levels should.

correspond to the training objectives of vocational education and the learning objectives of professional core courses in education stages, so as to keep the consistency of training objectives and teaching requirements.

Navigation technology is a national controlled, which is relatively professional, and related to the national security, public security of the special industry. Candidates apply

for the navigation technology major are to comply with the certain conditions and standards. When applying for these majors, universities need to be more strictly approved by the Ministry of Education. At the same time, the enrollment plan of maritime technology majors is strictly controlled, therefore the employment orientation is relatively precise and the specialty orientation is clear. On the one hand, the Marine technical specialty is led by the competent department of education, and also guided by the competent department of the industry - the national MSA. Therefore, the relationship between 1 and x of navigation technology major is closer. 1 is the foundation, and x points to the professional orientation of the Marine technology major.

Navigation education has straightened out the mutual recognition of credits between 1 and x. Generally, in the process of academic education, X's teaching or training content is inserted to complete X's training and teaching, and then apply for the examination or evaluation of Maritime Administration, the industry's competent authority, to obtain X certificate. Therefore, the teaching hours also belong to x training hours, which is included in the plan of 1. The training content of "X" certificate is integrated with the course content of the training program for navigation professionals. The vocational skill training of x certificate is not to design a set of training system and the curriculum system independently of the teaching of navigation major, but to organically integrate the training content of the certificate into the training program of professional talents of navigation major education. If the professional education courses can cover the content of x certificate vocational skills training, x certificate training will not be set up separately; The X training content that is not covered by professional education courses is supplemented, strengthened and expanded by the training module of Maritime Vocational Skills certificate. Students who have got academic certificates can be exempted from part of the examination when they take part in the examination of maritime vocational skill level certificate. Students who have obtained vocational skill level certificates can be recognized as the credits of their academic education according to regulations and exempted from taking corresponding courses or modules. The exchange of academic certificate and vocational skill level certificate lays a foundation for the construction of national qualification framework.

According to the relevant requirements of "the 20 Articles on Vocational Education", the training and evaluation organizations of x certificate are open recruitment and selection for the society, rather than the competent departments of education administration, its subordinate institutions or entrusted specific institutions to undertake the corresponding functions. The training and evaluation organization of X certificate should be socialized, responsible for the quality and reputation of the certificate, able to bear corresponding legal responsibilities and have the status of independent legal person. The examination, training and certification of professional qualification certificates of seafarers should be separated from teaching and examination. Nautical colleges are responsible for the academic education and pre-examination training of nautical majors. The National Maritime ADMINISTRATION RECRUITS QUALIFIED assessors and examiners from shipping enterprises, competent authorities and universities to assess the suitability of trainees, which is a third-party evaluation. This kind of socialized mechanism plays the role of market at the same time, also give full play to the functional role of the government. The government provides a good institutional environment and

establishes a sound supervision and management mechanism, so as to make the "1 + x certificate system" matures and support vocational education reform, and then support industrial innovation and development.

5 The Conclusion

What kind of talent should professional undergraduate course cultivate after all? Popular VIEW IS THE REQUIREMENT THAT LEVEL OF ACADEMIC THEORY OF DISCIPLINE SHOULD ACHIEVE COMMON UNDERGRADUATE COURSE, PROFESSIONAL SKILL SHOULD EXCEED THE REQUIREMENT THAT HIGH VOCATIONAL SCHOOL GRADUATES. In fact, it emphasizes the importance of "1" and "X", and highlights the requirements of "X". The vocational undergraduate of Marine technology major must pay attention to the cultivation of students' theoretical knowledge of the subject, cultivate students' cognitive ability, and establish correct world outlook, outlook on life and values. This is very important to train high-quality seafarers. At the same time, students should be combined with the actual situation and career development planning, to provide students with reasonable vocational skills or qualification training, help them to obtain the corresponding vocational skills or vocational qualification certificate, highlighting the advantages of vocational education [14]. Clarifying the connotation and logic of "1 + x" will help to clarify the direction of professional development. The former is the foundation, the latter is on the basis of the former to highlight the improvement of vocational skills, at the same time, the latter also plays a role in promoting the teaching reform of the former, solving the problem of structural or absolutely shortage of crew supply, so as to settle down the problem of the structural shortage or absolutely shortage of Chinese seafarers' supply.

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