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Continuous Assessment In Electric Power Engineering For Marine Engineers

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CONTINUOUS ASSESSMENT IN ELECTRICAL POWER ENGINEERING FOR MARINE ENGINEERS

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ABSTRACT

To tackle the climate challenge, all sectors need to contribute, including electrified shipping. Electrified shipping is not only propulsion but also loading and unloading equipment. This transformation requires increased skills and understanding of electric power engineering for the personal onboard, not least for the marine engineers. Therefore, a changed in the curriculum was needed. However, when more theoretical course content was added to two consecutive courses, the student view and passing rate dropped. Although the student view improved quickly, the passing rate recovered slower. To address this issue, continuous assessment was introduced to counteract the drops. The aim of this study was to evaluate the theoretical parts and determine if continuous assessment could contribute to improve student learning and increase passing rate. The students expressed satisfaction with the changes, and the passing rate has increased. Most students also claimed that they learned more compared to standard assessment methods.

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1 INTRODUCTION

The trend of electrification of propulsion (Kersey, Popovich, and Phadke 2022) has also come to the shipping industry even though it is delayed compared to many others part of the society. This is mainly due to technical challenges like size, weight and cost of batteries (Kersey, Popovich, and Phadke 2022), but now the development goes fast and the number of fully electrified ships worldwide is increasing rapidly, especially in the Nordics countries (Tarkowski 2021). But it is not only the propulsion that has become electrified (Wärtsilä 2022), also the loading and unloading of equipment is electrified.

The disruptive electrification transition in the shipping industry put new requirements on the needed skills for all that work in the shipping business, like Marine engineers. A curriculum development project was done in the academic year 2017/2018, in two consecutive 7,5 credit courses in the Marine engineer education at Chalmers University of Technology (Chalmers), based on the Standards of Training, Certification and Watchkeeping (STCW) A-III/1, A-III/2, A-III/6 and A-III/7 (International Maritime Organization 2019). The purpose was to meet the new requirements that the electrification demands while still fulfilling the STCW requirements. In the first course the focus was more on general knowledge on how to handle basic models of electric components, like resistances, inductances, and capacitances, and how to solve more extensive problems. This was done to prepare the students for the more complex systems that are expected on electrified ships, and which will be harder to grasp intuitively. The second course emphasises on models of actual electric components, like electric machines, cables, and power electronics converters, but also include systems aspects on components interaction as well as high voltage. A stronger component influence on system behaviour is expected to be needed to handle the rapid development in the areas of electrification. High voltage was also included as more land connections as well as systems on board are above 1 kV.

The marine engineer students are unique as a student group since they often have more applied view on knowledge and therefore often has low interest and experience of theoretical studies as they are focusing on professional degree (Hindhede and Højbjerg 2022). Therefore, they often do not have a developed and/or an individually adapted study technique which is challenging for the academic teachers (Hindhede and Højbjerg 2022). During the last decade the interest of potential students to the marine engineering program has decreased and since the academic year 2015/2016 all eligible students has been accepted. This has led to a large spread in pre-knowledge and in study techniques, despite no change in admission requirement. The number of students in the course has varied over the studied period between 7 and 53 with a mean number of 31 and 38 for respective courses.

The passing rate of the two courses dropped at the same time as the curriculum development was done, which initiated a development of the assessment process. The desired outcome of the development was to:

- Get the students to work continuously throughout the course.
- Increase the passing rate during the first year of the course.
- Assess knowledge rather than skills.
- Increase the interest in getting feedback, they do not learn from their mistakes.

In addition, there is an extra requirement to show that all learning outcomes was assessed due to the certification according to the SCTW requirement.

A system of continuous assessment was introduced in an attempt to meet the above mentioned goals. Continuous assessment is an ongoing process of monitoring, evaluating, and providing feedback on the progress of student learning over time. It is known to improve student learning by providing ongoing feedback to students and helping them to identify their strengths and weaknesses, so they can make adjustments to their learning strategies (Hattie 2012). It can also encouraging students to stay engaged and focused throughout the course (Rosadoa et al. 2022). Moreover, it can also help the students in breaking down the learning into, for them, more manageable parts and to take ownership of their learning by enable them to set goals and monitor their progress over time. The outcome of continuous assessment has shown to lead to better grades, a higher passing grade and improved engagement in course activities (Korhonen et al. 2022). However, there are drawbacks (Hattie 2012), like time-consuming for both students and teachers, puts higher constant pressures on the students and it might limit the learning with a too narrow focus on the assessment in the learning situation.
The main outcome of this paper is to find out to what extent continuous assessment can support marine engineering students to meet the new requirements that the electrification demands through more advanced studies in electric power engineering.

2 METHODOLOGY FOR REVISION AND EVALUATION OF THE ASSESSMENT

The first course, basic electric power circuits course (BEPC), is given in the second half of the first semester during the first year. The second course, Electric Power System and Component course (EPSC) is given in the first half of the first semester in the second year. The implementation was done step-wise, first in the BEPC due to a more pressing situation and then in the EPSC.

2.1 Basic Electric Power Circuits

Previously the assessment was three laboratory work and a written final exam. During an intermediate period of two years, three small exams were provided during the course, giving bonus points to the written final exam. Since 2020/2021 the written exam is divided in three parts, A) on DC circuits, batteries and cables, B) on AC circuits and C) on three phase system, the DC machine, and transformers. Each part counts for two credits each. The three laboratory work are kept as before and gives 1,5 credits. Students that have passed one part, does not have to remake that part. The final grade is determined by the total points of the three parts, but at least 50 % is required on each part. The three laboratory work are all 4 hours long and has been

the same since 2017/2018, first part is on DC, the second is on AC and the DC-machine and the third is on the three phase system and the transformer.

2.2 Electric Power System and Components

Previously, the assessment was divided into three parts, five occasions with laboratory work, three short hands-in related to regulations at sea and a final written exam. Since 2022 the written exam is replaced by three hand-ins. To verify that the students have answered the hand-ins themselves there is an oral follow-up. If the students pass the follow-up, they get grade 3 on that hand-in, which is the lowest grade for pass. For higher grade, a more traditional oral assessment is done. The five laboratory works are the same since 2017/2018: the first is on the synchronous generator and generator operation in a small power system, the second is on the asynchronous motor including starting methods, the third is on power electronics and converters, the fourth is on high voltage phenomena and the final is on cable sizing and protection settings.

2.3 Evaluation

For the entire studied period 2013/2014 to 2022/2023 the answers on the anonymous written standard evaluation form of the university are used. The data from these forms are used for the long term and trend studies. As completement an extra anonymous written evaluation was done during 2022/2023 just before and after the EPSC. Data regarding grades and passing rate were retrieved from the national student administration system, available via the public principle.

3 RESULTS

In the written standard evaluation form, there is one question where the students are asked to rate the overall impression of the course, from grade 1 very poor to grade 5 excellent. In Figure 1 the average overall impression of the BEPC and EPSC together with the average of the yearly overall impression of all courses in the program are shown.

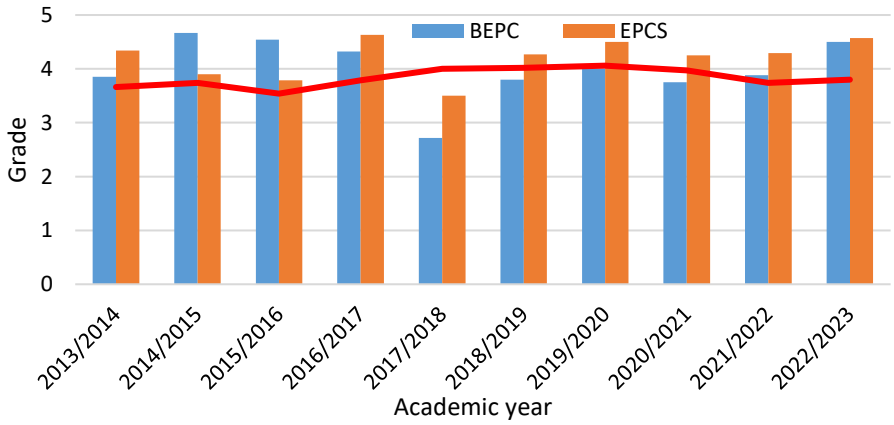

Figure 1. Average overall impression of the BEPC and EPSC and the yearly average for the marine engineering program at Chalmers. The scale is from grade 1 very poor to grade 5 excellent.

As can be noticed in the figure there is a significant drop in the overall impression for year 2017/2018. That year the teaching staff and the examiners of both courses were replace together with that the curriculum was developed. The large drop was restored the year after and the courses has returned to be better than the program average, though it took longer time for BEPC to recover.

In Figure 2 the grade distribution for the BEPC is shown. The result is the total after the three possible attempts to pass the exam(s) of the year they registered for the course. The results are the combined distribution of all the three possible exam occasions during each year. The grading scale is that grade 5 is for between 100 % and 83 % of the total number of points, grade 4 is for between 83 % to 67 %, grade 3 for 67 % to 50 % and the student fail, grade F, if the summation of the points scoored on the tasks are below 50 % or not all parts has at least 50 %. As can be seen in the figure the failure rate has increased from 2016/2017 and the distribution of students with the highest grade has also decreased compared with the earlier years. As mentioned before, in 2020/2021 the final exam was divided into three smaller exams and from Figure 2b) it can be noticed that the failure rate has decreased from 2020/2021 and the number of students that got the highest grade have increased, at least in study year 2020/2021. As can also be noticed in the figure there are some students that have passed two and one of the three exams. This means that these students can focus on the remaining exam or exams and do not need to study for the part/parts they have already passed. It should be highlighted that the number of students in the course in study year 2018/2919 was much lower compared to the other years.

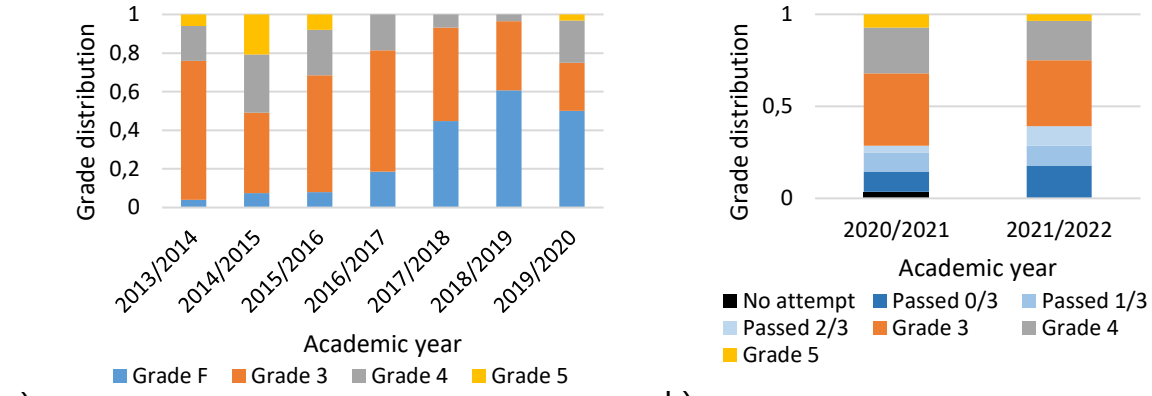

Figure 2. Grade distribution for the BEPC, where a) is for 2013/2014 to2019/2020 and b) is for 2020/2021 and 2021/2022 where continuous assessment was applied.

In the second course, EPSC, the assessment did not change until 2022/2023. In Figure 3 the grade distribution can be seen. The result is the total after the three possible attempts to pass the exam(s) of the year they registered for the course. However, not all students utilize that possibility. Students that pass the course after the first year after registration are not included in the statistics. It can clearly be seen that the passing rate decreased 2017/2018 due to the content change in the course. In 2022/2023 there was a significant raise in the passing rate and the students that

failed did not even tried to solve any of the hand in assignments. The outcome of the new assessment has meant fewer fails and more students with grade 3, but not more students with grade 4 and 5. This probably means that the system does not contribute to grade inflations. Around 80 % of the students stated that they got the grade they aimed for.

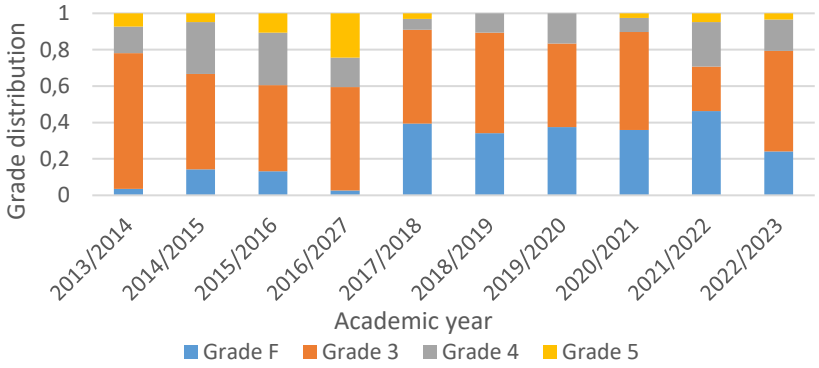

Figure 3. Grade distribution and failing rate for the EPSC

There are two other factors that could contribute to the increased failing rates from 2017/2018 in the two courses. One is that from this year all eligible students were admitted to the program, which means that some students were admitted with low merits. The other factor is that the number of students that has been admitted to the program has been dropping between the years 2014/2015 to 2018/2019 and then the number of students has slowly increased, but only to approximately half of the number of students that was admitted in 2014/2015. This means that the number of students in the courses are low and some of these students have low merits. This could contribute to a decreased passing rate and lower grades of the students. Unfortunately, it is not possible to differentiate these effects form the effect of a new course setting and teachers.

In Figure 4 the student view on the relation between the assessment and the learning outcomes are shown. The question deals also with the expectations of the assessment as it has a high correlation with the result of the assessment.

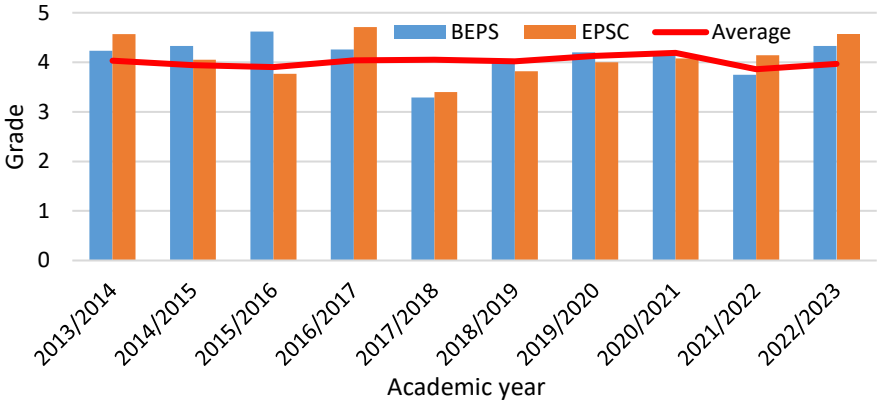

Figure 4. Students grade (1-5, where 5 is the highest) on however the assessment of the course is related the learning outcome of the course.

Overall, the student thinks the assessment is suitable for both the courses. There is also here a drop in 2017/2018 followed by a recovery that levels out, but for the last year there is another step in the right direction.

It can be seen that students prefer the continuous assessment, but the different set-ups fit different students. As was expressed by a student:

> *"Good new take on the exam, it promotes learning!"*
>
> Anonymous student taking EPSC in 2022/2023, translated from Swedish by the authors.

On a direct question if the student learned less, the same or more due to the new set-up in the EPSC, 95 % stated that they learned more and the last 5 % stated that he/her learned less. The claimed higher degree on learning and also higher passing rate, see Figure 3, can be explained by the reoccurrence of learning opportunities, during the teaching, at the hand-ins and then as preparation of the oral follow up. Another explanation is that the students were stressed for the oral follow-up, so they did not dare to show up unprepared. Almost half of the students claimed that the oral follow-up was stressful, but some also claimed that written exams can be stressful.

4 DISCUSSION

When introducing continuous assessment in the two courses also the structure of the courses was adapted for this. The courses were divided into smaller parts and all teaching elements that supported the students learning of one part was given before the next part was started. The assessment of the part was done approximately a week after all teaching of the part ended. It was done in this way because the later parts build on the previous parts in the course. Since the assessment is close to the end of the previous part the students should have a good understanding of it so they can use it as the base of the following part. In this way the course structure helps the students with a preferred order of learning. The division into smaller parts also means that the amount of material that needs to be studied for each assessment is smaller and this can make it easier for the students since they have a limited part of the course material to study for each assessment. For the BEPC, from 2020/2021, the students also get each part reported individually and after completing all the parts they get a final grade on the course. This means that if a student fail on one part, the student only needs to study that part again and take the reexam for that part of the course. This helps the students to know which part and which material to focus on. From Figure 2 and Figure 3 it can be seen that the failing rate increased when the curriculum was developed, but it has decreased since. From Figure 4 it can be seen that the students thinks that the assessments tests that they reach the intended learning outcomes of the course and if the students mark this question with this high numbers, it usually means that they also think that the assessment is fair. From Figure 1 it can also be noticed that the overall impression of the courses is good and

if the grading of the course is this high it usually means that the students like the course. It is good courses with fair assessments, but difficult.

The continuous assessment provides continuous feedback on the progress of the student, especially related to the passed parts. However, for the not passed parts it is more problematic, apart from the actual result, especially for the BEPC. In the course the students get an example of a solution for the exams and are invited to discuss their solution with a teacher, but no one has ever done that. In the EPSC the students need to, and do, address the not passed part to not fall behind in the assessment process.

Moreover, using different assessment methods can provide a more comprehensive and accurate picture of an individual's abilities and strengths (Suskie 2018). Therefore, it's important to choose an appropriate range of assessment methods for everyone, to help them maximize their learning and achieve their potential.

Oral communication, trained in the oral follow-up, is essential for marine engineers, particularly in situations where safety and efficiency are paramount. By prioritizing effective oral communication, marine engineers can perform their duties more effectively and minimize the risk of accidents and other safety incidents (Ahmmed 2018; Øvergård et al. 2015). But training in verbal communication is also important for the sometimes stressed psycho-social environment onboard, which may occur due to fact they work close together for longer periods of time (Thorvaldsen and Sønvisen 2014).

5 CONCLUSIONS

The developed assessment methods make/forces the students to work continuously throughout the courses and might have contributed to the increased passing rate. The oral follow-up focuses more on knowledge then the skills and practice technical oral communication but is quite stressful. It also gives an opportunity to give direct feedback on any misunderstandings in a way that is hard to do in writing. At least in the EPSC the students really read and sometimes even discuss the short comings in their work.

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