Using a web-based simulation software in education

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ABSTRACT

Manoeuvring ships in confined waters is a complex issue and requires extensive education, training and practical experience. Using Seaman Online™, the instructor builds and publishes specific exercises which the students can access by logging in to their account from any computer connected to the internet at any time. After having completed an exercise, students can replay the simulation on an evaluation page where all important manoeuvring data are presented in a graphical and numerical format. There are several areas in ship handling where Seaman Online™ may not only support the student in their training and understanding of the complexity of ship behaviour in various manoeuvring conditions but also their analytical skills. These areas may be categorized into applied hydrodynamics, ship handling using tugs and repetitive training in berthing/un-berthing manoeuvres. On a general level, Seaman Online™ was perceived by the students as a useful complement to the desktop and bridge simulators.

1. INTRODUCTION

Manoeuvring ships in confined waters and ports is a complex issue and requires extensive education, training and practical experience. As no maritime academy will conceivably be able to provide a student with enough practical experience (which in addition may be ship specific), the challenge for the educator lies in how to convey valuable and essential understanding and skills in ship handling with limited resources such as simulation exercises.

The requirements on the competency for Masters and Chief Mates on ships of 500 Gross Tonnage or more to manoeuvre and handle a ship in all conditions are specified in STCW Table A-II/2 [1]. Many of these requirements are covered during the third year of the Master Mariner education at Chalmers University of Technology in the course “Ship handling and navigation in confined waters” which primarily focuses on the following topics:

- Applied hydrodynamics (IMO manoeuvre tests, shallow water effects, interaction, etc.).
- Manoeuvring characteristics of different ships including the controllable, semi-controllable and uncontrollable forces involved in ship handling.
- Planning, executing and monitoring passages in confined waters such as archipelagos (blind pilotage techniques on radar, controlled turns, etc.)
- Manoeuvring large ships with and without the use of tugs.

The teaching methods consist of lectures, exercises in the bridge simulator and some limited practical manoeuvring training on a small ship. To further support the student's learning, Chalmers and SSPA have developed a web-based simulator, Seaman Online™. This web application builds on SSPA's simulation software Seaman™ and uses high-quality mathematical models originating from SSPA's comprehensive data bank from model tests conducted during the last 60 years.

1.1. SEAMAN ONLINE™

Seaman Online™ is the most recent extension of SSPA's existing core simulation software with an interface influenced by the work done in the European Commission project CyClaDes [www.cyclades-project.eu] and by further user feedback during other full-mission simulation projects [2].

Seaman Online™ consists of being able to run simulations using SSPA's well-known and high quality ship and tug models in a 2D birds-eye visualization of the Electronic Navigational Chart (ENC) combined with a conning display and an evaluation page of the simulation results, including quantitative feedback to users about their manoeuvring exercise performance and ship dynamics forces and effects.Using Seaman Online™, the instructor builds and publishes specific exercises which the students can access by logging in to their account from any computer connected to the internet at any time. No software needs to be downloaded as Seaman Online™ runs directly on a web page.

After having completed an exercise, students can replay the simulation on an evaluation page where all important manoeuvring data such as forces, moments, rudder angles, etc. from the run are presented in a graphical and numerical format facilitating the analysis of the run (see figure 1 and 2). By saving and flagging a completed exercise by the student, the instructor gains access to the evaluation page of the run to assess the performance.

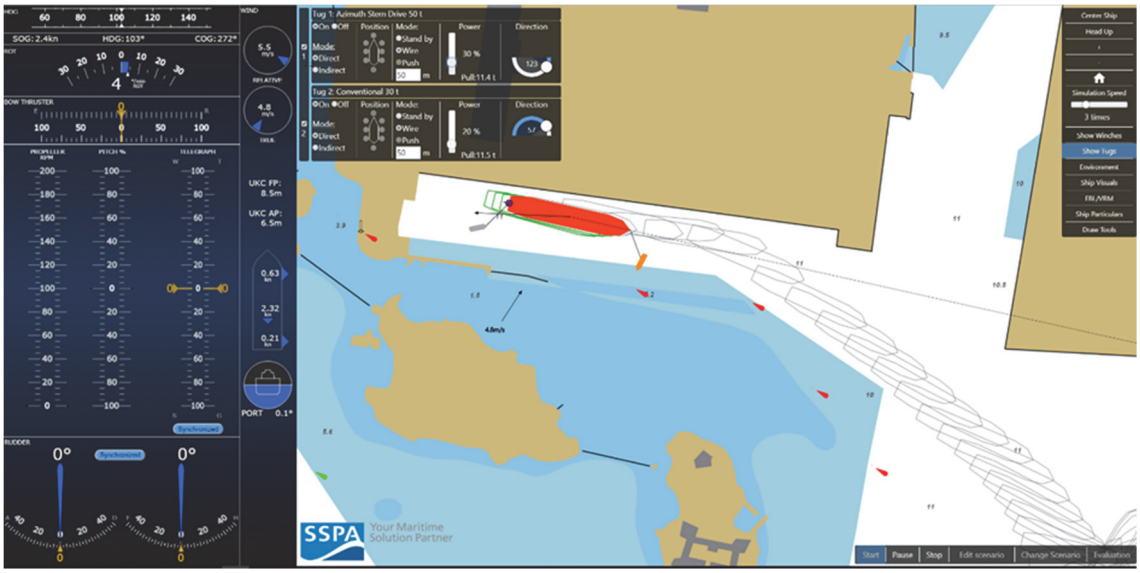

Figure 1. Running a berthing exercise with tugs in Seaman Online™.

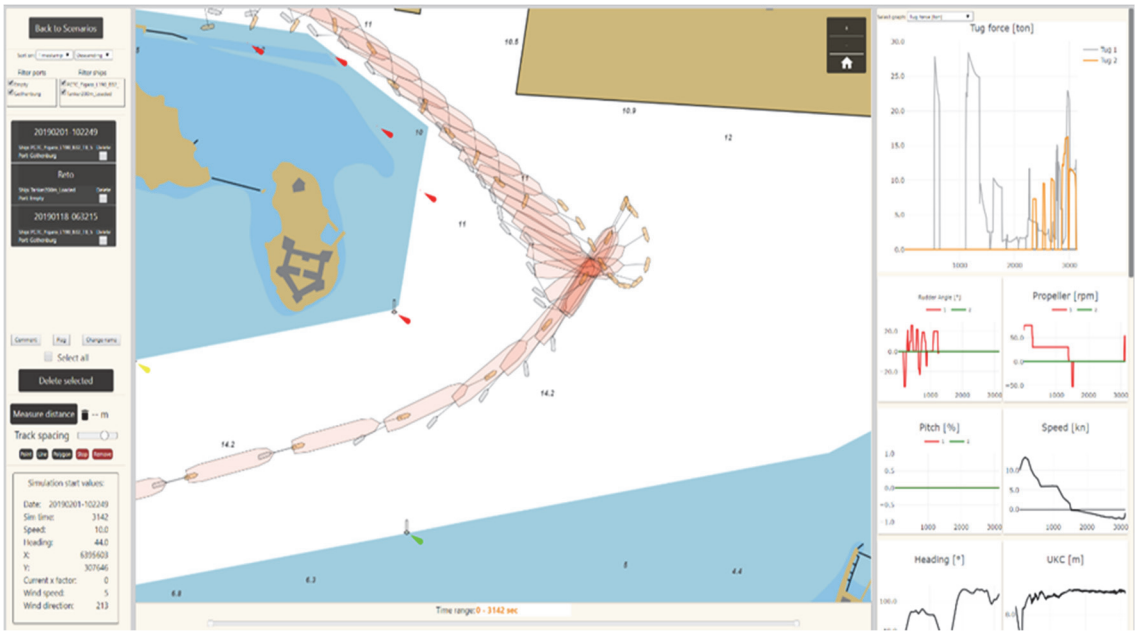

Figure 2. Evaluation page of a simulator run.

1.2. USING APPROPRIATE SIMULATION TECHNOLOGY TO FACILITATE LEARNING AND UNDERSTANDING

In the course "Ship handling and navigation in confined waters", simulators ranging from relatively simple desktop stations to bridge simulators are used extensively to mainly train blind pilotage radar techniques in confined waters, anchoring and berthing manoeuvres with relatively large ship models (i.e. a Panamax tanker and a PCTC).

The main purpose and goals for these simulation exercises is to bridge the gap between theory and practice and as an effective aid for training and competency assessment of future ship masters and deck officers. All exercises are run in confined waters (chart areas Sydney and Gothenburg) with bridge teams consisting of a navigator and co-navigator. The students are observed and assessed by the instructor(s) during all exercises focusing on the objectives and goals as stated in the exercise instructions. If it is found that the student is not showing enough proficiency, a re-run of the exercise is arranged. For such kind of exercises, a bridge simulator is highly suitable as it not only enables the use and training concerning all relevant and necessary navigation and communication equipment but also as it provides enough space to accommodate a bridge team. However, training using bridge simulators is relatively expensive and requires a lot of resources.

In contrast, certain aspects of ship handling may not need the infrastructure and resources of a bridge simulator and may be better trained, visualized and analysed by preferably using other simulation tools especially if the goal of the exercise is not only to provide training and skills but also to encourage the students to critically examine and understand the behaviour of ships in certain manoeuvring situations. As an additional benefit, students are given the possibility to practice and learn at any time and in any place they wish at a comparatively low cost.

2. SUITABLE EXERCISES FOR SEAMAN ONLINE™

There are several areas in ship handling where Seaman Online™ may not only support the student in their training and understanding of the complexity of ship behaviour in various

manoeuvring conditions but also their analytical skills. These areas may be categorized into:

- applied hydrodynamics,
- ship handling using tugs and
- repetitive training in berthing/un-berthing manoeuvres.

2.1. APPLIED HYDRODYNAMICS

Applied hydrodynamics in ship handling is understood as the effect of various hydrodynamic forces due to e.g. hull form, under-keel clearance (UKC), interaction with banks and other ships. Although some of these hydrodynamic effects may be shown and experienced using a bridge simulator, the student will have a "bridge perspective" and in the case of interaction with e.g. bank or other ships conceivably only try to counteract the forces without having the possibility to study and analyse the exact nature of the forces. Other effects such as the influence of the UKC on the drift angle of a ship or the influence of the hull form on the turning properties are even less suitable to be run in a bridge simulator as they are basically only visible when running a log file after the completed simulation run.

Seaman Online™ not only uses high-quality mathematical ship models but also provides the user with an evaluation page where significant data from a simulation run is presented in both graphical and numerical form forming the basis for an analysis. Parameters such as water depth, ship model, distance to the bank or other ship, etc. are easily changed giving the possibility to really study and analyse the behaviour of a ship in various conditions. Example of a simulation of bank effects and its evaluation page are shown in Figure 3 and 4.

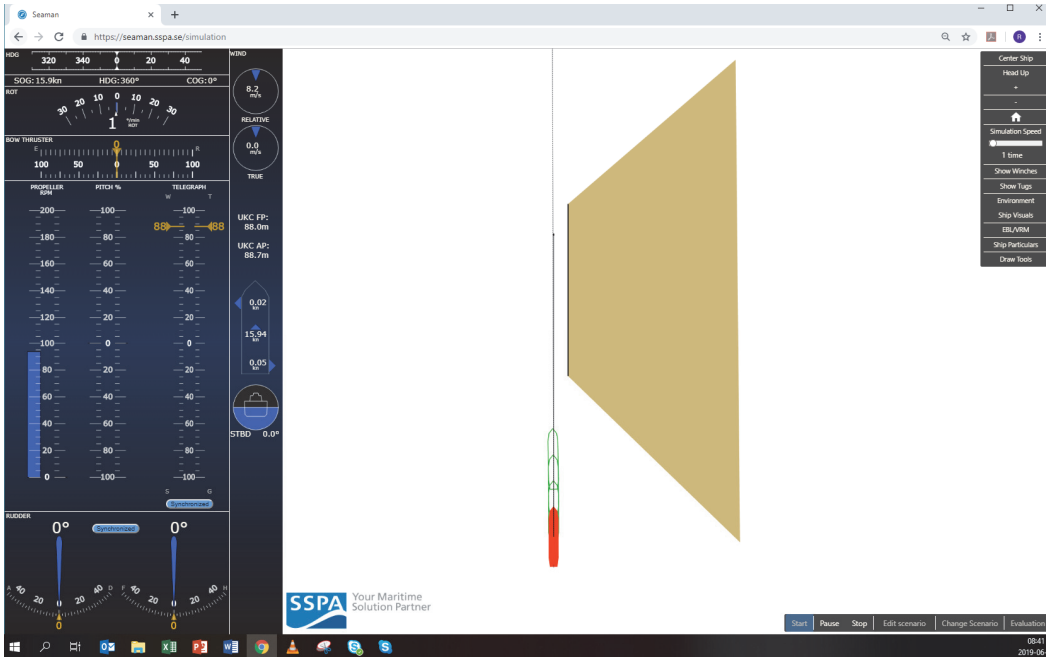

Figure 3. Running an exercise simulating bank effects

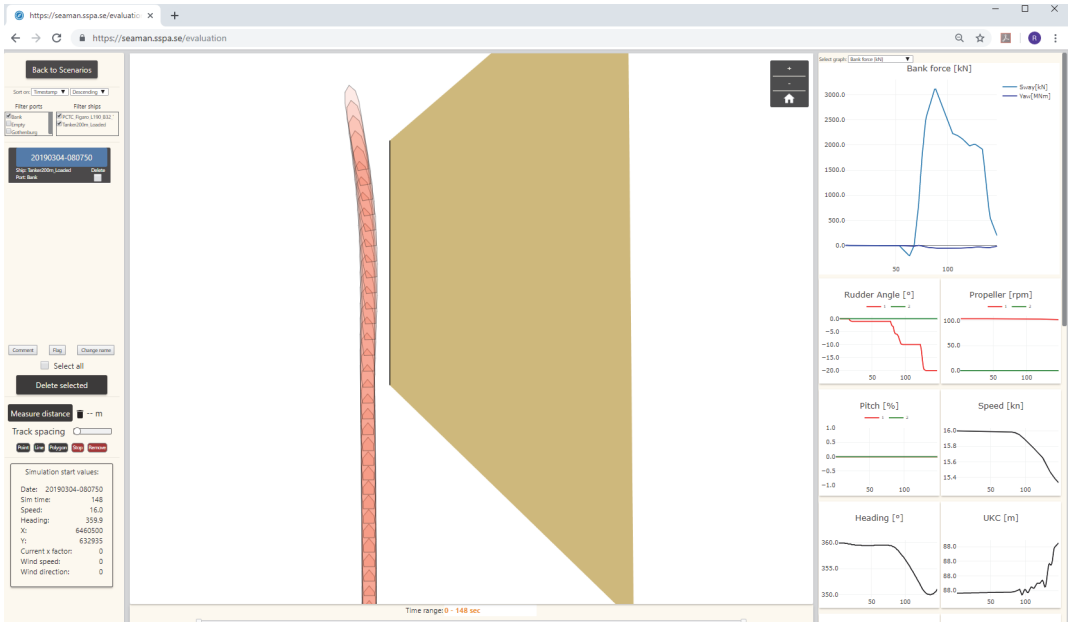

Figure 4. Evaluation page on bank effects

2.2. USING TUGS

Combined with lectures on handling ships with tugs, Seaman Online™ provides an ideal platform for students to execute and analyse manoeuvres with tug assistance to obtain a far clearer idea on how such manoeuvres may be performed. Usually bridge simulators are seldom used for students to practice with tugs and in case an exercise involves tugs, these may be run only by the instructor as a target.

Different tug types are available in Seaman Online™ and depending on their properties may be used in both direct and indirect mode as depicted in Figure 5. The user is both manoeuvring the ship and the tug(s) and thereby gaining an overall perspective on the complexity of handling ships with tugs. As with all simulations run in Seaman Online™, the evaluation page after a completed exercise provides the student with data to examine and analyse the manoeuvre (see figure 6).

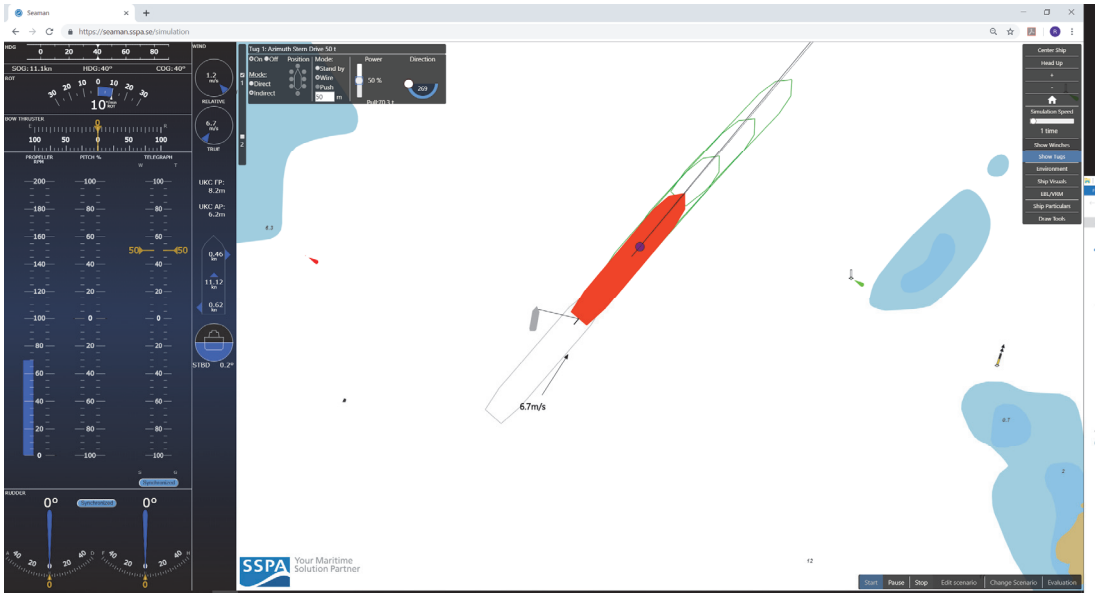

Figure 5. Simulation with a tug in indirect mode

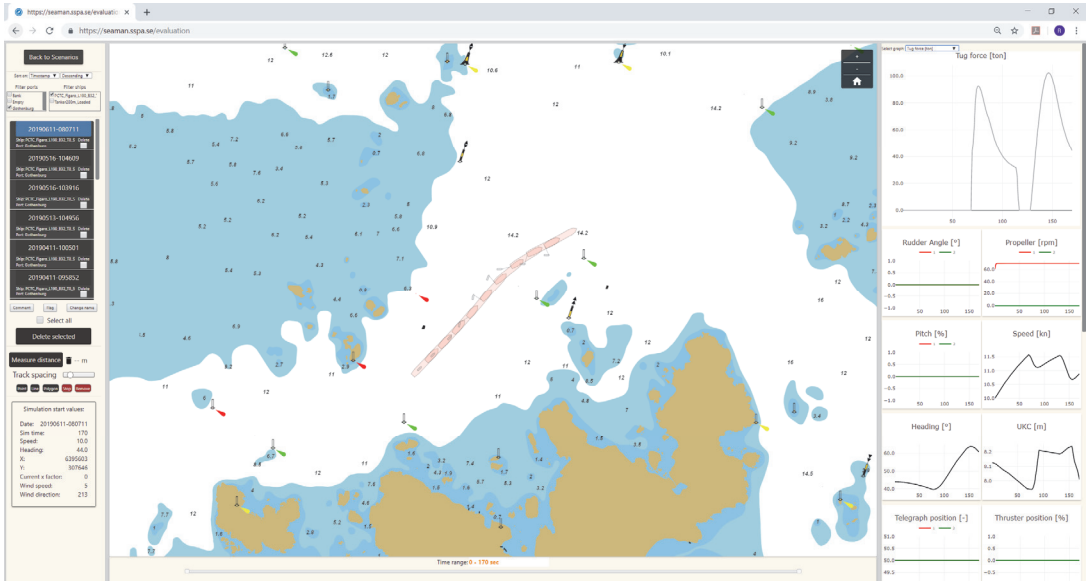

Figure 6. Evaluation page of a simulation with a tug

2.3. REPETITIVE TRAINING IN BERTHING/UN-BERTHING MANOEUVRES

To become proficient in handling ships requires both theoretical knowledge and years of practice and no simulation is likely to replace reality as the technical and environmental challenges, the real risks involved, and possible commercial pressures cannot be simulated. Nevertheless, simulators have matured into a valuable asset in education, training and studies by providing realistic real time rendering of an almost real environment. However, the degree of fidelity does not necessarily determine the success of the learning outcomes and may on the contrary add unnecessary complexity and distraction [2]. Complex simulation techniques have been found to be less suitable in basic skill training, and different types of simulation technologies can be used as a complement to each other to increase fidelity [3]. Or to phrase it differently, different levels of simulation throughout different points of the curriculum are normally required for training [4].

Seaman Online™ will not provide an environment as realistic as in a bridge simulator except the behaviour of the ship model itself. However, the simulation tool provides the user with the possibility to practice "bulk" training of manoeuvres such as berthing and un-berthing with and without tug assistance (see Figure 1 and 2), testing limits (e.g. wind limits) and experiment with alternative berthing plans. Being web-based, Seaman Online™ significantly increases the availability of a ship manoeuvring training tool and may be one step in a progressive continuous learning program in which the student first studies the theory and then progresses with applying the theory and practices the manoeuvre(s) in Seaman Online™ followed using the bridge simulator and eventually gaining real life experience.

3. INSTRUCTOR'S ROLE IN USING SEAMAN ONLINE™

Seaman Online™ was made available to Master Mariner students enrolled in the course "Ship handling and navigation in confined waters" as an additional resource. Four different exercise assignments (pertaining to applied hydrodynamics and manoeuvring with and without tugs) were set up by the instructor to be executed and analysed by the students. Instructions, purpose

and goals for each exercise were documented and published on the course web-page. Through saving and flagging a completed exercise by the student, the instructor gained access to the evaluation page of the run to assess the performance. Additionally, the students were to send in a written report by e-mail reflecting their analysis of the performed manoeuvre(s) as per instructions.

In contrast to instructor led exercises using the bridge simulator, the user of Seaman Online™ is very much on his own when doing the exercises and may not get any immediate feedback or help. The objective of a simulation may seem obvious to an instructor but possibly not fully understood by the students and thereby influencing their perception, experience and learning [2]. Clear task description and instructions are essential and may even be combined with a short briefing during an ordinary lecture. Depending on the exercise, particularly the instructions concerning the analysis task need to be very specific even to the point that students are to compare and explain numerical values at specified events in their analysis.

Debriefings to gauge and ensure that students do not learn something incorrectly are an essential part in any simulator-based training [5]. When executing simulations outside of an instructor's supervision, this process differs from the usual class room debriefings and feedback may be given by e-mail instead. Having access to the evaluation page combined with a written report/analysis allows the instructor to assess the performance of the students individually and any mislearning or incorrect analysis may be easily captured. However, it is of utmost importance that the assessor takes this task seriously and is prepared to be engaged in potentially lengthy e-mail conversations with the students.

From the instructor's perspective letting students execute exercises outside of their supervision may also raise concerns related to the possible "video game effect" i.e. that students regard the web-based simulations as purely a game without any correlation to reality and thereby may neither appreciate nor fulfil the learning objectives of the exercises. To a certain extend these concerns are justified and there are likely to always be some students which consider all simulation exercises as games. However, on the other hand one of the advantages of using Seaman Online™ in e.g. berthing manoeuvres is that the students are encouraged to test and experiment with different approaches and will eventually be able to not only appreciate the complexities in ship handling but also gain confidence in being able to safely manoeuvre the ship alongside without any instructor interfering. It is believed that although there is the risk of some students considering the web-based simulations as purely a video game, the majority of students actually take the exercises very seriously and the benefit of Seaman Online™ outweighs the concerns of the "video game effect".

4. FEEDBACK FROM USERS

The unpublished paper "Testing Proof of Concept of a Web-Based Ship Manoeuvring Training Tool in the Classroom" by Costa et al. [2] describes the first-time implementation of Seaman Online™ in the context of a Master Mariner university programme and the students' perception on its usability and usefulness. On a general level, Seaman Online™ was perceived as a useful complement to the desktop and bridge simulators and appreciated as an opportunity to test, on a personal computer, manoeuvres and situations normally not tested in the desktop or bridge simulators or onboard ships [2].

5. CONCLUSIONS

There are several areas in ship handling where Seaman Online™ may not only support the student in their training and understanding of the complexity of ship behaviour in various manoeuvring conditions but also their analytical skills. Being web-based, Seaman Online™ significantly increases the availability of a ship manoeuvring training tool and may be one step in a progressive continuous learning program. Clear task description and instructions are essential and depending on the exercise, particularly the instructions concerning the analysis task need to be very specific. Having access to the evaluation page combined with a written report/analysis allows the instructor to assess the performance of the students individually and any mislearning or incorrect analysis may be easily captured. However, it is of utmost importance that the assessor takes this task seriously and is prepared to be engaged in potentially lengthy e-mail conversations with the students.

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