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ACTIVE LEARNING FOR ENHANCED UNDERSTANDING OF “SHIP DAMAGE STABILITY”

Abstract:

Active Learning has always played an important part of seamen’s education. Transfer of experience have from ancient time been practiced in an active learner-centered field where unexperienced seamen got involved in their own learning by being supervised by experienced seamen, when practicing seaman related activities. This learning practice was supreme before the introduction of “modern” maritime educational institutions. This introduction led to development of an education field with a passive more teacher-centered learning style in addition to traditional practical active learning style, on sea.

Damage Stability is one important topic of modern Ship hydrostatic and Ship Stability subjects of the ship-officer education. This topic have traditionally been lectured in a passive teacher-centered learning style, which may have limited the development of basic developmental knowledge and understanding.

This paper will present a conceptual framework of an Active Experimental Learning platform for enhanced developmental knowledge and “in-depth” understanding of Ship Damage Stability. Advantages and possible disadvantages of Active Experimental Learning related to this presentation are going to be discussed. In addition to this presentation, the paper will present a lighter survey to clarify how a selected number of Maritime Education and Training schools, at bachelor level, plan their approach to this topic according to required competence by STCW.

Keywords:

Active Learning, Ship Stability, Damage Stability, IMO, STCW, SOLAS, MET

Introduction

Infante Henry established the first school of Maritime Education and training (MET) in 1419 (Dong 2013). This school of MET focused on education in oceanic navigation along with an astronomical observatory at Sagres, Portugal. In this school, people were trained in nagivation, map-making, and science, in order to sail (Enhancedlearning 2018). This establishment led to the introduction of an onshore education field with a passive teacher-centered learning style.

In the following centuries, MET schools were increasingly focused on different onshore passive learning styles, and less focused on traditional active learning styles. This development ensured that students could pass exams in some subjects just by showing a certain level of “undevelopmental” knowledge and calculation skills, but not necessarily based on a deeper understanding of the core of a subject. Undevelopmental knowledge, by definition, consists just of dispensed matter delivered of an instructor. This instructor could be a teacher, which deliver this knowledge to passive students who may just ingesting this knowledge for recall on tests (Barr & Tagg 1995). Technical and profession-orientated passive learning styles can easily be performed without analyzing the basic questions. Focus on superficial aspects rather than on a deeper understanding can be an important challenge for the profession-orientated educations such as for ship officers. To achieve deeper understanding is complex, and it dependeds on a well-developed and rich base of knowledge and skills upon developmental level. A deeper understanding also involves flexible understanding in solving real problems or cope with challenges such as operating a ship.

Some decades, university classes comprised highly selected students with high academic capacities. These “academic” students have the capacity of following a traditional passive teacher-centered learning style, which seemed to work well. Today’s student population is more diversified as entry requirements have been lowered. Classes with highly selected students have, some places, been replaced with students of more varying academic capacities (Biggs 1999). This varied student population has provided teachers with challenges regarding the customization of learning styles that provide the best learning outcomes for all students. “Non-academic” students are to a lesser extent able to adopt more than a surface approach to learning when presented with the traditional passive teacher-centered learning styles. These students might benefit from learning styles that challenge their higher order cognitive activities in a different way than the learning style suitable for “academic” students.

Good teaching is getting most students to use the higher cognitive level processes that the more academic students use spontaneously (Biggs 1999).

Seafarers education is today highly regulated by the *International Convention on Standards of Training, Certification and Watchkeeping for Seafarers* (STCW) convention

(IMO 2018). This International Maritime Organisation (IMO) convention sets standards and requirements for the educational outcome for ship officers and other personnel for merchant ships. Combinations of MET subjects related to STCW are complex, and most subjects fit traditional passive teacher-centered learning styles. According to John Biggs (1999), this learning style makes it difficult for all students to get a deep understanding of different important topics of some subjects. He proclaims that the teacher's job is to create a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes for all students (Biggs 1999).

The importance of having a deeper understanding of different operative settings when operating a ship is significant. The challenge is then to describe and develop technology and environment for learning that maximizes the chance of engaging students with different prerequisites to achieve this deep understanding.

Modern MET schools use different simulator facilities to make the learning process as realistic and active as possible. By using simulators, students get involved in their learning by using different navigational and communication equipment in realistic exercises. This occurs in an environment where they have to solve different challenges in cooperation with other students. The challenge is that simulator-based learning or training is currently limited to teaching navigation and cargo handling. Educational institutions that teach and train for operative professions like ship officers or airline pilots should strive for learning styles that provide deeper understanding. John Dewey (1929) meant that we gained experience through activity, but that we did not acquire deep and lasting understanding directly from this experience. Deep and lasting understanding is achieved through evaluation and reflection upon the experience gained (Dewey 1929).

This paper argue the importance of letting the students be involved in their learning of damage stability, which is an important topic of ship stability. More specifically, a realistic laboratory exercise where the students get actively involved in different scenarios for water inlet in a specially constructed model ship. The research hypothesis are:
“Emotional-*engagement-related learning activities provide improved phronetic-based learning outcome”.*

The motivation for this article is based on the following expressions (Eison 2010):

Tell me and I'll listen. Show me and I'll understand. Involve me and I'll learn. (Teton Lakota Indians).

I hear, and I forget. I see, and I remember. I do, and I understand. (Asian proverb)

Statement of the problem

Over the last decades, the shipping industry has focused on the development of improved ship structure and ship equipment in order to increase the reliability of ship systems, reduce causalities and increase efficiency and effectiveness. This evolution has led to technologically advanced and more reliable ships. Despite this improvements, there is still not a significant reduction in risk of accidents and incidents. The casualty rate is still high. From 2014 to 2016, the number of reported causalities has stabilized around 3200 per year (EMSA 2016). This number is probably higher as a result of under-reporting (EMSA 2016). According to EMSA‘s analysis of 1170 accident events, 60.5 percent were directly attributed to erroneous human actions (EMSA 2016). The overall number of human factor related causalities are probably higher. Other research shows that 75-96 percent of maritime accidents are directly or indirectly caused by some form of human error (Hanzu-Pazara, Barsan, Arsenie, Chiotoroiu, Raicu 2008). No matter what these numbers are, the human factor is assumed to be the main causality of all marine accidents.

There are different opinions about the underlying causes of these human factor related accidents, but some of these accidents are related to poor situational assessment, situational awareness, and practical wisdom in advance, during and after accidents. MET institutions must strive to provide the students with the best possible basis for exercising their practice according to Aristotle`s expression, Phronesis. Phronesis is the intellectual virtue which appears in well-executed actions. Intellectual virtue has its origin and development through experience-oriented learning (Stigen & Rabbås 2013). In-depth understanding and knowledge of any subject is a prerequisite for exercising well-executed actions.

The objective of this paper was to present a concept of how to provide students with developmental knowledge and in-depth understanding of damage stability.

Ship Stability

“Ship stability is an area of naval architecture and ship design that deals with how a ship behaves at sea, both in still water and in waves, whether intact or damaged” (Wikipedia 2018).

There are two basic approaches to ship stability, intact stability and damaged stability.

- Intact ship stability deals with stability of a ship with an intact ship hull.
- Damage stability deals with stability of a ship with a damaged ship hull with subsequent water inlet i.e. loss of buoyancy and stability.

Knowledge of both intact- and damage stability is important topics of the education of ship officers and naval architects. Damage stability is an advance technologic topic, which builds on the understanding and knowledge of intact stability.

Damage stability is all about knowing what condition a ship will achieve after an incident with water inlet. The main features of this topic are whether the ship will sink or stay afloat, and how it will stay afloat after experiencing water inlet and loss of stability (Barrass & Derrett 2012)

Methodology

The main objective of this article was to present a developed learning platform for the establishment of developmental knowledge and understanding. The learning platform is formed as an empirical research method, using empirical evidence based on actual theory. The empirical method is, according to John Dewey, the only method that can do justice to the inclusive integrity of experience (Dewey 1929, P.9).

The purpose of this learning platform is based on factors of learning to achieve the best knowledge and understanding for performing well-executed actions. In essence, the choice of the theoretical platform is decisive for the methodical approach of a review. Therefore, the search strategy was comprehensive to embrace wide. The articles were collected and reviewed from different databases like Google, Google Scholar, Researchgate, Sciencedirect and IMO. keywords used: ”Aristotle`s basic perspectives of learning, John Biggs`s *teaching for enhanced learning*, John Dewey`s *learning by doing*, active learning, experimential learning, experience learning (empiricism), how people learn, basic factors referred to maritime education and training and STCW. In addition to the article review, some parts of The books, Aristotle`s “The Nicomachean Etics”, Ann Gravel`s “Principles & Practices of Teaching and Training“, John Dewey`s “Experience And Nature“, Brandsford, Brown & Rodney`s “How People Learn: Brain, Mind, Experience, and School: Expanded Edition” and Barrass, C. B. & Derrett`s “Ship Stability for Masters and Mates, Seventh Edition” formed the basis for this article.

The following objectives were input to the literature review:

- Relevant theory referring to learning styles, and especially active and experimentally learning.
- Relevant theory, referring to ship and damage stability.
- Formulation of the statement of the problem area.

The empirical part of this study consists of an explanation of the development of the active learning platform and a document-survey related to STCW requirement and how MET schools curricula`s meet these requirements. The development of this learning platform related to damage stability started two years ago. This learning platform is an extension of three already established learning platforms at the University of Tromsø. The three former learning platforms concentrate on the establishment of developmental knowledge and deeper understanding of intact ship stability. The theory in this article is the foundation for the learning platform for both intact and damage stability. The framework for the learning platform is:

1. A pre-activity part that students carry out prior to the experiment
2. The laboratory experiment
3. A post-activity following the laboratory experiment

The damage stability learning platform is presented in detail later in this article.

Two document review`s was undergone, one to get an overview of what requirements the STCW convention set for the educational outcome of ship officer students. A second document review of selected MET school curricula`s was also undergone to determine whether these satisfy the STCW requirements and also look for possible improvement:

1. Competence requirements set by The International Maritime Organization (IMO) convention, STCW.
2. Curricula`s of six different selected MET schools. All these MET schools graduate ship officer students on Bachelor level. The different MET schools are anonymized and titled from MET 1 to MET 6. The following were considered relevant to this review:
   - STCW reference:
   - STCW “Damage Stability” requirements:
   - Credits:
   - Teaching methods:
   - Workload:
   - Evaluation method:

Active learning

Active learning has several definitions relevant to this paper, all stating something about students active or experimental involvement in their learning processes.

Bonwell & Eison`s (1991) definitions cover most of the core of this learning style:

- *"a method of learning in which students are actively or experientially involved in the learning process.".*
- *"Anything that involves students in doing things and thinking about the things they are doing."*

The learning style is not organized so that the students are supposed to be a sort of spectator. Active learning takes into account that students do not learn much just by sitting passively in a classroom listening to teachers, remembering what the teacher says and powering prepackaged assignments to spit out the right answers. The active learning style is mainly the opposite of passive learning; it is learner-centered, not teacher-centered, and give a basis for the acquisition of experience. M. J. Adler (1982) points out that: "*All genuine learning is active, not passive. It involves the use of the mind, not just the memory. It is the process of discovery in which the student is the main agent, not the teacher*" (Richardson, Morgan & Fleener 2009, P.380).

Bonwell & Eison`s first definition describes the core of the active practical or experimental part of the learning style, where the students acquire new experience. The second definition describes the cognitive and metacognitive perspectives of this learning style. The cognitive and metacognitive perspectives of the learning style relate to post activities where the students evaluate, reflect, discuss and conceptualize the acquired experience. According to John Dewey, the real deep and lasting learning acquires through evaluation and reflection upon gained experience (Dewey 1929).

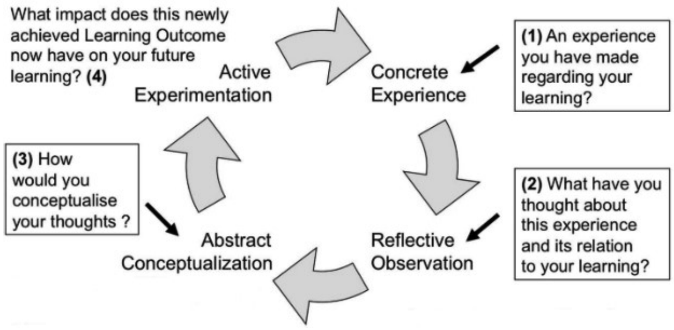
Bonwell & Eison`s (1991) created the following characteristics of Active Learning related to their definitions:

- *Students are involved in more than listening.*
- *Instruction emphasizes the development of student skills more than just transmits information.*
- *Students develop higher order thinking skills (analysis, synthesis,evaluation).*
- *The students are engaged in activities (such as reading, discussion, writing).*
- *The students examine their own opinions and values*.

These characteristics relate to the development of the appropriate Active Learning platforms related to this article, where (a) *pre-activity* bring the students into the content of the activity, purpose of the activity, possible outcome of the activity etc. In this pre-activity phase, the student will hopefully be positive emotionally influenced by the activity. A positive emotional state and a certain level of curiosity are essential for students engagement in activities, i.e. good motivation. (b) *An activity* that gives the possibility to gain appropriate experience, and a (c) *post-activity* so that the students get able to reflect upon the experience. Students must talk about what they are learning, write about it, relate it to experiences, and apply it in their daily lives. They must make what they learn part of themselves (Chickering & Gamson, 1987).

This learning activity phases (pre, activity, and post) could easily be related to David A Kolb`s experimental learning theory, represented by his four-stage experimental learning cycle. Kolb learning cycle applies to a combination of classroom pre-activities, hands-on laboratory sessions and the post-activity where students conceptualize their reflection of the observations.

Figure 1. David A. Kolb's Experimental Learning Cycle



McLeod, S. A. (2013). Kolb - Learning Styles. Retrieved from www.simplypsychology.org/learning-kolb.html

1. Concrete Experience – (*a new experience or situation encountered, or a reimpregnation of existing experience*). It is the phase of the learning platform where all experiences from the activity is stored in the memory.

2. Reflective observation – (*of particular importance are any inconsistencies between experience and understanding*). In this phase, the discrepancies between experience and understanding is developed.

3. Abstract Conceptualization - (*reflection gives rise to a new idea, or a modification of an existing abstract concept*). It is the phase where the learning by the reflection takes place. When passing from thinking about the experiences to interpreting them, one enter into the realm of what Kolb termed 'conceptualization.' To conceptualize is to generate a hypothesis about the meaning of our experiences.

4. Active Experimentation - (*the learner applies them to the world around them to see what results are achieved*) (McLeod 2013).

According to Kolb, effective learning only occurs when a learner can execute all four stages of the learning cycle. Therefore, no stages of the cycle are effective as a learning procedure on its own (Konak, Clark & Nasereddin 2013).

STCW - Competence requirements set by the IMO convention, STCW.

International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), 1978 was adopted seven. July 1978, and entered into force on 28 April 1984. The main purpose of the Convention is to promote safety of life and property at sea and the protection of the marine environment by establishing in common agreement international standards of training, certification and watchkeeping for seafarers.

Part A of the STCW Code is mandatory. This part indicates minimum standards of competence required for seagoing personnel given in detail in a series of tables. "*Standard of competence is the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with the internationally agreed criteria as set forth herein and incorporating prescribed standards or levels of knowledge, understanding and demonstrated skills"* (IMO/STCW).

Standards of competence are required to be demonstrated by candidates for the issue and revalidation of certificates of competency under the provisions of the STCW Convention. STCW requires that training leading to the issue of a certificate is 'approved,' i.e. MET schools and subjects concerned by the convention has to be approved to meet these requirements (IMO).

The STCW convention distinguishes between the following standards of competence:

1. Competence
2. Knowledge, understanding, and proficiency
3. Methods for demonstrating competence
4. Criteria for evaluating competence.

These standards of competence have the following level of responsibility:

1. Management level
2. Operational level
3. Support level

The following figures show tables for controlling the operation of the ship and care for persons on board at management- and operational levels related to ship stability and damage stability.

Table A-II/1 Specification of minimum standard of competence for officers in charge of a navigational watch on ships of 500 gross tonnage or more. Function: operational level.

Figure 2. Controlling the operation of the ship and care for persons on board at the operational level (STCW/CONF.2/34)

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Maintain seaworthiness of the ship	*Ship stability* Working knowledge and application of stability, trim and stress tables, diagrams and stress-calculating equipment Understanding of fundamental actions to be taken in the event of partial loss of intact buoyancy Understanding of the fundamentals of watertight integrity *Ship construction* General knowledge of the principal structural members of a ship and the proper names for the various parts	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training, where appropriate .4 approved laboratory equipment training	The stability conditions comply with the IMO intact stability criteria under all conditions of loading Actions to ensure and maintain the watertight integrity of the ship are in accordance with accepted practice

Table A-II/2 Specification of minimum standard of competence for masters and chief mates on ships of 500 gross tonnage or more. Function: management level.

Figure 3. Controlling the operation of the ship and care for persons on board at the management level (STCW/CONF.2/34)

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Control trim, stability and stress	Understanding of fundamental principles of ship construction and the theories and factors affecting trim and stability and measures necessary to preserve trim and stability Knowledge of the effect on trim and stability of a ship in the event of damage to and consequent flooding of a compartment and countermeasures to be taken Knowledge of IMO recommendations concerning ship stability	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training, where appropriate	Stability and stress conditions are maintained within safe limits at all times

According to the content of the tables, graduated students are required to have the following standards of competence:

- At operation level

"*Understanding of fundamental actions to be taken in the event of partial loss of intact buoyancy"* and *"Understanding the fundamentals of watertight integrity"*.

- At management level

"Knowledge of the effect of trim and stability of a ship in the event of damage to and consequent flooding of a compartment and countermeasures to be taken" (IMO)

There is no required standard of competence related to the topic at the support level.

Curricula`s from the different selected MET schools (Bachelor level)

MET 1.

- STCW reference: A-II/1 and A-II/2
- STCW “Damage Stability” requirements: Knowledge and understanding of basic Damage Stability and ship structural parts and waterproof subdivisions.
- Credits: 7.5
- Teaching methods: Ordinary teacher-based lectures
- Workload: -
- Course evaluation: written exam

MET 2.

- STCW reference: none
- STCW “Damage Stability” requirements: Knowledge about fundamentals of watertight integrity and basic knowledge regarding the consequence of failure of a ships structural parts and critical components. Skills to describe and demonstrate the fundamentals of watertight integrity, describe and demonstrate fundamental actions to be taken in the event of partial loss of intact buoyancy and describe and demonstrate effects on trim and stability of a ship in the event of damage to and subsequent flooding of a compartment and actions to be taken.
- Credits: 7.5
- Teaching methods: Ordinary teacher-based lectures
- Workload: Completed four out of five written obligatory individual submissions or workshops.
- Course evaluation: Proctored written exam 3 hour

MET 3.

- STCW reference: A-II/1 and A-II/2.
- STCW “Damage Stability” requirements: Knowledge of stability after damage and grounding. Skills to do basic calculations of stability after damage and grounding.
- Credits: 15
- Teaching methods: Ordinary lectures and workshop
- Workload: Submissions (specified at the start of semester).
- Course evaluation: Part 1: Written exam, 5 hours, count 60% on final grade.
  Part 2: Written exam, 4 hours, count 40% on final grade.

MET 4.

- STCW reference: A-II/1 and A-II/2.
- STCW "Damage Stability" requirements: Skills to account for concepts related to vessel intake stability and stability in a damaged condition.
- Credits: 10
- Teaching methods: Ordinary lecture, group exercises, written individual exercises
- Workload: 3 mandatory submissions with reflection notes
- Course evaluation: Written exam 6 hour.

MET 5.

- STCW reference: A-II/1 and A-II/2.
- STCW "Damage Stability" requirements: No specific
- Credits: 6
- Teaching methods: Ordinary lectures and workshops
- Workload: none
- Course evaluation: Written exam

MET 6.

- STCW reference: A-II/1 and A-II/2.
- STCW "Damage Stability" requirements: Knowledge in calculating the ship's stability, fitness and flow performance based on given conditions, both with and without water intrusion. Basic competence regarding the preservation of the ship's seaworthiness and survival ability in hull damage.
- Credits: 10
- Teaching methods: Ordinary lectures, workshops, laboratory group exercises
- Workload: 3 mandatory laboratory exercises with reflection notes, completition of five out of seven written obligatory individual submissions.
- Course evaluation: Written exam 5 hour

Active Learning platform (damage stability)

The damage stability laboratory experiment is one of four laboratory experiments for the ship stability subject. All these experiments give the students in-depth treatment of different important topics of the subject. The first three experiments deal with intact stability topics, while the fourth deals with damage stability. There must be a sufficient number of depth studies for students to grasp the defining concepts within a specific area of a subject (Brandsford, Brown & Rodney 2000). Rather than covering all topics of a subject, it may be beneficial for the students to gain in-depth knowledge on fewer topics. It may allow key concepts in the subject to be understood better.

The learning concepts are so that it provide an additional learning acquisition process, depending on the already acquired theory. Intact stability ship stability is the foundation for understanding damage stability. The goal is to provoke a transfer of learning by using past learning of intact stability when learning damage stability (Haskell 2001). Transfer of learning or transformative learning refers to development and change of perception of fixed assumptions and expectations through both self-control and critical reflection (Illeris 2004).

The active experimental learning platform in question is a laboratory experiment using a ship model. The experiment is a group work project with three participants in each group. Research has identified an advantage by using small groups in this type of active learning. It facilitates discussion skills like, listening, questioning, and responding, which are important factors for discussing and thinking. It is worth noting that the success of small group learning depends on the responsibilities taken by each of the members of the group in combination with the tutor or teacher (Edmunds & Brown 2010)

The purpose of developing this laboratory experiment is to facilitate active involvement in their learning process, i.e. give the students the best basis for achieving “practical wisdom” (*Phronesis*). Practical wisdom is the basis for solving unpredicted and challenging situations and work with theories within the topic. To be wise, one should make different experiences and at the same time remain open to learning from these experiences. It should not be saved for experience-giving situations, following others recipes (Rabbås & Stigen 2013).

All four Ship Stability related experiments consist of three basic steps: 1. pre-activity, 2. laboratory experiment activity, and 3. post-activity. The rationale behind this learning platform is learning with understanding, Brandsford J.D, Brown, A. & Coocking, R.R. (2000)

Pre-activity

- Go through the necessary theory and present the purpose of the laboratory experiment.
- Present the laboratory experiment and what the expected learning outcome of the experiment should be.
- Introduce the students for the post-activity part of the laboratory experiment.

The content of the pre-activity was chosen with the intention of provoking positive emotions, i.e. influence the benefits of the experiment, benefits being one of the most important factors for achieving commitment to acquiring new experiences. According to Dewey, students chooses experiences that benefit and reject what does not benefit.

The laboratory experiment was developed in the test basin at The Arctic University of Tromsø UiT. The actual exercise deals with three different scenarios of water intrusions.

Scenario 1. Damage with subsequent water intrusion to port tank 1
Scenario 2. Damage with subsequent water intrusion to port tank 1, 2 and 3
Scenario 3. Damage with subsequent water intrusion to the four front subdivisions, tank 1 and 2, both starboard and port.

The purpose of selecting these three specific scenarios was to allocate enough time for the post activity, i.e., evaluation and reflection upon the empirical outcome of the scenarios. According to Bloom's original Taxonomy of educational objectives, *evaluation* is the most complex intended learning outcome. Nevertheless, objectives that involve understanding and use of knowledge were classified in categories from *comprehension* to *synthesis*, which is usually considered as the most important goals of education. David R. Krathwohl further developed the taxonomy into four dimensions of knowledge, instead of Bloom`s six categories where knowledge was considered the lowest graded learning objective. Krathwohl replaced Bloom`s *evaluation* with *Metacognitive Knowledge* – knowledge of cognition in general as well as awareness and knowledge of own cognition (Krathwohl 2002). This learning objective is the superior goal for the development of this learning activity.

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Figure 4. Illustration of different selected water inlet scenarios

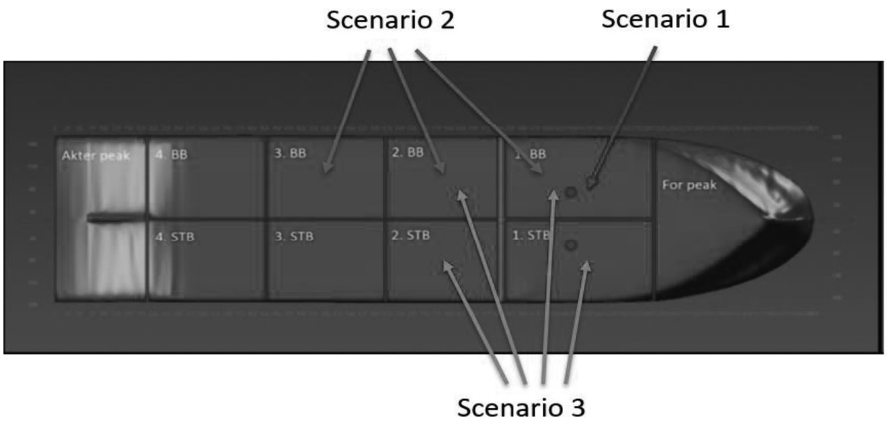


Figure 5. Empirical outcome of scenario 1

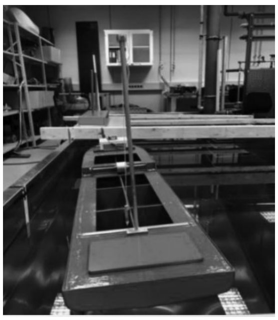
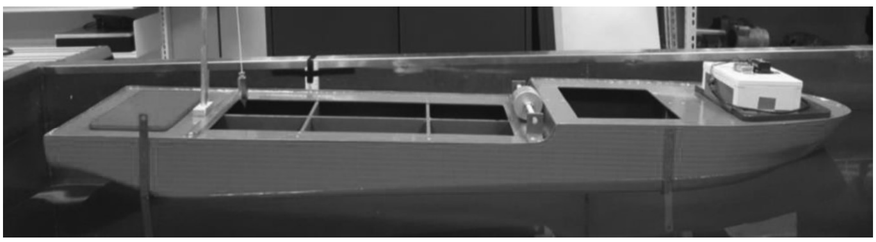


Figure 6. Empirical outcome of scenario 2

Figure 7. Empirical outcome of scenario 3

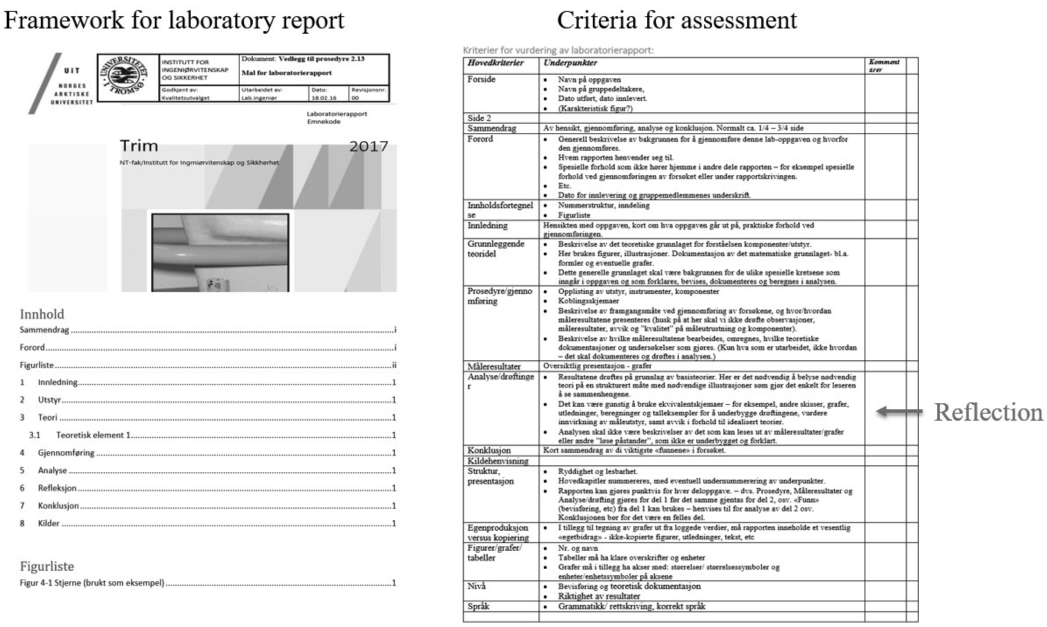


Source: Skjønsfjell, Osvoll and Frøynes. UiT

Post activity

The laboratory experiment is supplemented by the student groups, writing a report where they are encouraged to evaluate and reflect upon their learning from the empirical trials compared to prior experience and basic theory. The purpose is to set the students mental activities in motion and try to let them be conscious of the processes of their learning. Comparing empirical attempts to former experience and theory will influence the understanding, and probably give the students a better foundation to solve analytical calculations and handle practical challenges needed in the profession. According to Dewey, the learning outcomes of the subject would be optimized by evaluating and reflecting upon the gained experience. Evaluation and reflection of gained experience with existing experience also facilitate transformative learning conditions

Figure 8. Illustration of framework for post activity, own figure



UIT NORGES ARKTISKE UNIVERSITET

INSTITUTT FOR INGENIØRVITENSKAP OG SIKKERHET	Dokument: **Vedlegg til prosedyre 2.13** **Mal for laboratorierapport**	
Godkjent av: Kvalitetsutvalget	Utarbeidet av: Lab.ingeniør	Dato: 18.02.16	Revisjonsnr. 00

Laboratorierapport
Emnekode

Trim 2017

NT-fak/Institutt for Ingeniørvitenskap og Sikkherhet

Innhold

Figurliste

Kriterier for vurdering av laboratorierapport:

Hovedkriterier	*Underpunkter*	*Kommentarer*	
Forside	• Navn på oppgaven • Navn på gruppedeltakere, • Dato utført, dato innlevert. • (Karakteristisk figur?)		
Side 2			
Sammendrag	Av hensikt, gjennomføring, analyse og konklusjon. Normalt ca. 1/4 – 3/4 side		
Forord	• Generell beskrivelse av bakgrunnen for å gjennomføre denne lab-oppgaven og hvorfor den gjennomføres. • Hvem rapporten henvender seg til. • Spesielle forhold som ikke hører hjemme i andre dele rapporten – for eksempel spesielle forhold ved gjennomføringen av forsøket eller under rapportskrivingen. • Etc. • Dato for innlevering og gruppemedlemmenes underskrift.		
Innholdsfortegnelse	• Nummerstruktur, inndeling • Figurliste		
Innledning	Hensikten med oppgaven, kort om hva oppgaven går ut på, praktiske forhold ved gjennomføringen.		
Grunnleggende teoridel	• Beskrivelse av det teoretiske grunnlaget for forståelsen komponenter/utstyr. • Her brukes figurer, illustrasjoner. Dokumentasjon av det matematiske grunnlaget- bl.a. formler og eventuelle grafer. • Dette generelle grunnlaget skal være bakgrunnen for de ulike spesielle kretsene som inngår i oppgaven og som forklares, bevises, dokumenteres og beregnes i analysen.		
Prosedyre/gjennomføring	• Opplisting av utstyr, instrumenter, komponenter • Koblingsskjemaer • Beskrivelse av framgangsmåte ved gjennomføring av forsøkene, og hvor/hvordan måleresultatene presenteres (husk på at her skal vi ikke drøfte observasjoner, måleresultater, avvik og "kvalitet" på måleutrustning og komponenter). • Beskrivelse av hvilke måleresultatene bearbeides, omregnes, hvilke teoretiske dokumentasjoner og undersøkelser som gjøres. (Kun hva som er utarbeidet, ikke hvordan – det skal dokumenteres og drøftes i analysen.)		
Måleresultater	Oversiktlig presentasjon - grafer		
Analyse/drøftinger	• Resultatene drøftes på grunnlag av basisteorier. Her er det nødvendig å belyse nødvendig teori på en strukturert måte med nødvendige illustrasjoner som gjør det enkelt for leseren å se sammenhengene. • Det kan være gunstig å bruke ekvivalentskjemaer – for eksempel, andre skisser, grafer, utledninger, beregninger og talleksempler for å underbygge drøftingene, vurdere innvirkning av måleutstyr, samt avvik i forhold til idealisert teorier. • Analysen skal ikke være beskrivelser av det som kan leses ut av måleresultater/grafer eller andre "løse påstander", som ikke er underbygget og forklart.		
Konklusjon	Kort sammendrag av di viktigste «funnene» i forsøket.		
Kildehenvisning			
Struktur, presentasjon	• Ryddighet og lesbarhet. • Hovedkapitler nummereres, med eventuell undernummerering av underpunkter. • Rapporten kan gjøres punktvis for hver deloppgave. – dvs. Prosedyre, Måleresultater og Analyse/drøfting gjøres for del 1 før det samme gjentas for del 2, osv. «Funn» (bevisføring, etc) fra del 1 kan brukes – henvises til for analyse av del 2 osv. Konklusjonen bør for det være en felles del.		
Egenproduksjon versus kopiering	• I tillegg til tegning av grafer ut fra loggede verdier, må rapporten inneholde et vesentlig «egetbidrag» - ikke-kopierte figurer, utledninger, tekst, etc		
Figurer/grafer/tabeller	• Nr. og navn • Tabeller må ha klare overskrifter og enheter • Grafer må i tillegg ha akser med: størrelser/ størrelsessymboler og enheter/enhetssymboler på aksene		
Nivå	• Bevisføring og teoretisk dokumentasjon • Riktighet av resultater		
Språk	• Grammatikk/ rettskriving, korrekt språk		

Discussion

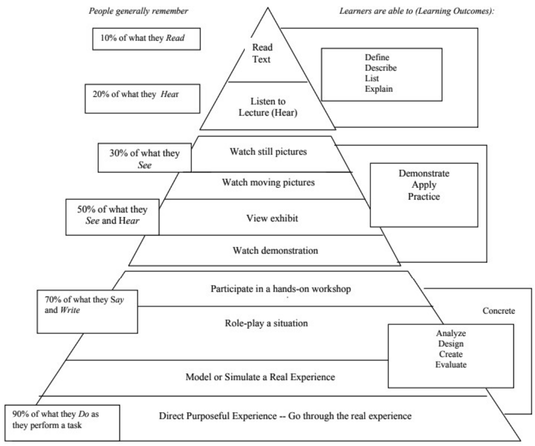
Evidence from a wide variety of different types of sources indicates that listening to a classroom lecture (teacher-centered learning) is not an especially effective way to promote deep and lasting student learning (Eison 2010). The discussion of this paper will clarify some important aspects of active or experimental learning. Focus will be on the different advantages and disadvantages or challenges that this learning style have on achieving deep and lasting learning. The ancient Greek knowledge-orientated approaches *episteme, techne* and *phronesis* will be linked to the argumentation related to these aspects. According to the Aristotelian ethics, episteme and techne, there is a link because of the relationship between scientific knowledge and the craft, art or even skills to practice according to this knowledge. Phronesis is the intellectual virtue, which consists of the ability to consider what craft, art or skills which contribute to the goal. These considerations are based on the conceptual scientific knowledge (episteme) (Stigen & Rabbås 2013).

The purpose for developing this laboratory experiment was to optimize the learning process for best possible, in-depth and lasting, developmental knowledge and understanding, i.e. a phronetic knowledge-orientated approach of this topic. Phronesis - orientated knowledge is the key to the development of situational awareness and assessment, which is essential for the performance of praxis. This knowledge approach relates to competence, which is the authority a person has to make the right decisions, i.e. performance of praxis. The purpose relates to the concept of constructing a deeper understanding that leads to the term of competence (Brandsford, Brown & Rodney 2000).

One challenge related to this phronetic knowledge-orientated approach is that this specific learning platform focus on the technical execution of learning, i.e., a knowledge-oriented approach to techne. Techne, which is associated with a technically orientated understanding, technical skill or proficiency to act contradicts the phronesis approach. It was, therefore, important to develop a learning platform that led to phronesis-orientated knowledge for situational awareness and assessment.

Different researchers and philosophes well document the advantages of active or experimental learning. For learning styles linking to the adaption of experience and degree of processing, this experience is essential. Dale's Cone of Experience is a model that incorporates several theories related to instructional design and learning processes. His research led to the development of the following Cone of Experience model (Dale 1969).

Figure 9. Dale`s Cone of experience model

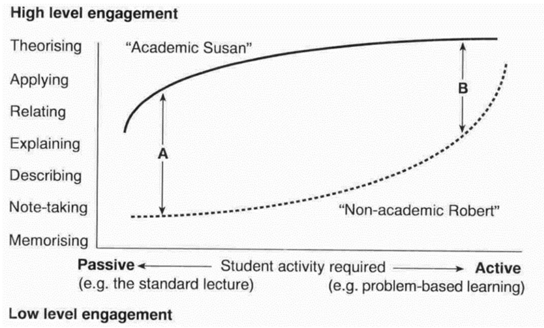


Source: Adapted from E. Dale, Audiovisual Methods in Teaching, 1969, NY: Dryden Press.

According to Dale (1969), the least effective learning method involves learning from information i.e. reading texts. The next to least effective learning method involves listening to a lecturer i.e. classroom-orientated passive teacher-based learning. The most effective methods involve direct and purposeful experience-based learning, such as hands-on or field experience, like the learning platform presented in this article. Dale`s cone of experience could be a helpful tool for instructors when making decisions about appropriate learning activities. Still, it probably makes little sense, nor is it probably feasible to base all learning of a specific subject just on active learning. Parts of the curricula has to based on ordinary lectures and other learning styles. The learning platform presented in this article, and the three already implemented learning platforms, take into account important topics of the subject “ship hydrostatic and ship stability.” These important topics form a basis for a deeper understanding of the whole subject.

Biggs` (1999) study of students level of engagement based on their academically commitment shows the advantage of active learning, especially, for “non-academic” students. Figure 10 shows that both academic and non-academic student’s benefits from active learning. The figure also shows that the engagement-gap related to passive learning (A) narrows as the cognitive activity engagement increases (B) (Biggs 1999).

Figure 10. Student orientation, teaching method, and level of engagement



Source: What Students Does: teaching for enhanced learning (Biggs 1999)

Teachers have to strive to organize the learning context in a way so that all students reach the highest level of engagement. Higher order learning processes relates to the level of students engagement (Biggs 1999).

The following main aspects of increased engagement was taken into consideration when developing the laboratory experiment:

1. Aspect of variety relates to active learning as an important motivational factor in the way that it prevents the learning process to be monotone and boring.
2. Aspect of explaining the purpose, benefits and expected outcome of the laboratory task. The purpose of the task is essentially to influence the student's emotions positively.
3. Aspect of collaboratively learning.

These aspects correspond to the emotional and social dimensions of learning which is relevant for the whole concept of learning (Illeris 2004).

This study deals with different aspects of when learning happens and the benefits of activating the students in their learning. Barriers to learning or learning obstacles are all reasons that directly or indirectly get in the way of abstraction of learning. These obstacles have different origins but regardless of that, learning obstacles act to weaken motivation, engagement, and energy for learning. Knut Illeris (2004) study of what happens when intended learning does not occur, present some interesting results. Illeris` found that a great majority of the participants had, for various reasons, an ambivalent attitude to the courses they were attending. This ambivalence strongly marked the learning taking place; the learners used a range of unconscious strategies to avoid involving themselves in the learning process. Illeris (2004) points out three main types of learning obstacles resulting in lack of learning: *mislearning*, *defense* and *resistance*. These obstacles relate to the *cognitive*, the *emotional* and the *social* learning dimensions.

- Mislearning is part of the cognitive dimension, which ensures that, for some reason, the content, impulse or message does not come through and leads to erroneous, or nonlearning.
- Defense or mental defense is a part of the emotional dimension, which deals with a defense against an overwhelming number of complexity of impulses and influences that we all are exposed to.
- Resistance is rooted in the social dimension, which deals with active nonacceptance, objection or a strong personal force against engagement (Illeris 2004).

It is worth noting that Illeris (2004) base the conclusions on a 3-year study of adult education from the perspective of the learner, dealing with various types of education for low skilled or unemployed adults in Denmark (Illeris, 2003a). However, it is reasonable to believe that some of these aspects of learning obstacles should be taken into consideration when planning for active or experimental learning platforms.

The document review of six different MET schools curricula`s was undergone to get an insight into how the schools teach their students to meet STCW requirements and, in addition, look for possible improvement. This review deals with the entire ship stability subject, and not the specific topic of damage stability. Specifications of STCW requirements for damage stability were specified in the document review. The document review did not show any concrete items missing related to the STCW competence requirements, except for MET 2 and MET 5. MET 2 did not refer to the STCW requirement table A-II/1 and A-II/2. MET 5 did not show any specific items regarding STCW “damage stability” requirements. All curricula’s except MET 5 shows that they meet STCW “Damage Stability” requirements either at knowledge or/and skills level. MET 6 shows that they meet these requirements at both knowledge and competence level. These findings highlight areas of improvement. STCW table, A-II/1 and A-II/2, require operational competence at knowledge, understanding and proficiency level. It is also apparent from the review that the size of the subject varies from 6 credits (MET 5) to 15 credits (MET 3). This variation appears to be large, given the requirements of the STCW. An improvement could be to standardize a minimum of credits for this subject. The workload is also an area for possible improvement. MET 5 did not show any workload, and there is a large variation in workload between the other MET schools. A standardized minimum workload could also be an important improvement proposal. One last proposal for improvement could be the introduction of some active learning platforms. MET 6 has three mandatory laboratory exercises with reflection notes. All MET schools should strive to implement some active learning platforms for the achievement of purposeful experience-based learning. All curricula`s had few or no differences if ignoring the mentioned differences. They seem to have, more or less, the same content and design. There may be several explanations as to why these similarities. The most likely cause may be that all MET schools have to meet the same STCW requirements in order to be approved. Thus, these MET schools' curriculums may be based on the wording in STCW.

Conclusion

There was two limitaions referred to this study. The first limitation was the number of MET school`s involved. This limited number of participating MET school`s was chosen because this part of the study should only provide an overview of curruculum degree of meeting STCW requirement, and gaining an estimate as input for further investigation. The other limitation was the lack of empirical evidence of improved learning outcomes, based on the theoretically expected learning outcomes. The reason is that no data are collected referred to the learning activity`s effect on improved developmental knowledge or deeper understanding. This type of survey have to be investigated in a further and more comprehensive study.

The desirable outcome of this Active Experimental Learning platform was not necessarily to score better on tests and exams but to give the students optimized conditions for achieving a thorough foundation of practical wisdom (phronesis), within the topic. Aristotle proclaims the following related to phronesis, *whoever is wise, are able to judge different outcomes of different actions, to justify why a particular action is the best and to put the action into life*. The total concept of understanding all perspectives of maritime, at sea, activities rest on the concept of seamanship. Seamanship is probably connected to phronesis.

According to the presented solution for active learning, using a laboratory ship, the students have three experiments covering different topics of intact stability. These experiments have been going on for several years and based on feedback from students, learning engagement, exam results and the students' ability to develop new research projects on the topic, it indicate some level of success.

Future work will include a more thorough study of how teaching and learning take place among a wider range of MET schools, worldwide. Further, future work will address differences in developmental knowledge and deeper understanding of damage stability between students who have participated in active learning platforms and those who have not participated, would also be the source of an interesting study.

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