

ASSESSMENT OF SITUATION AWARENESS OF STUDENTS BY SPAM: DEVELOPING QUESTIONS

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ABSTRACT

In accordance with researches about 70% percent of accidents at sea during recent years occurred due to the loss of situation awareness (SA) by Seafarer. The Situation Awareness is a part of a total competency of Seafarer, which is included in STCW 78 Convention and Code. The assessment of SA is extremely important and should be the part of MET process in maritime institutions. The paper is devoted to assessment of situation awareness of students in accordance with the provisions of STCW 78, as amended and which is worded as "obtaining and maintaining the situation awareness". The Situation Present Assessment Method (SPAM) for assessment of SA is described. Developing the questions to assess SA for students by SPAM and Leximancer software technique is presented.

Keywords: *Human element, situation awareness, STCW 78 Convention and Code.*

1. INTRODUCTION

Provisions of situation awareness included in STCW 78 Code by Manila amendments are important in maritime education and training (MET) of seafarers and have direct influence on safety, efficiency of shipping and protection of the marine environment, and therefore the assessment of SA levels has a great value. The deep understanding of this field can positively affect the process of training of Seafarers and reduce the negative influence of Human Element in accidents at sea.

It is quite clear that SA is the substantial portion of competency of Seafarer [1], but it is also obvious that it may be one of the most complex parts of it due to the high level of dynamics of environment. The student should understand and use the SA principles from the first steps of his/her education and training.

That is why, in this paper we propose two ideas to start with SA assessment, which can be used from the very beginning and based on the concept of present situation. The first is to include contextual SA into the subjects of MET process, based on chess approach, i.e. based on understanding present situation [2], described by the studied texts. The second basic idea is the following: any text describes some situation by means of concepts related between them and united by the general context. It can be structured and visualized by means of Leximancer software, which gives the teacher and students the picture of concepts relations (conceptual map) for better comprehension of the theme.

The assessment of SA and training of SA are interrelated processes. So, the results of SA assessment can be applied to improve training procedures.

We paraphrase classical definitions [3] of SA levels, having included the key terms as "the studied text" and "concept" in them. So, in this case the levels of SA can be defined as follows:

- Level 1 SA – Perception of main concepts from the studied text. This level includes the detection, recognition, and identification of significant concepts within a given text.

- Level 2 SA – Comprehension of main concepts in the studied text. It encompasses how students combine, interpret, store, and retain this information. Level 2 SA reveals a comprehension of the current state and an ability to make inferences about why some concepts are related.
- Level 3 – Projection of situation, described by the main concepts - the highest level of SA - includes the ability to forecast future situation events and their dynamics. This ability to project from current events and dynamics to anticipate future events allows for timely decision making.

Being guided by functional and logic relations between text concepts, there is a possibility to introduce the artificial dynamics into the situation in the text space, i.e. to model this dynamics.

In the given case - it can be the forecast of the alteration of certain concept in text space, instead of projection in time, i.e. we need to answer the question "What can happen with the related concepts in the text if to change values of their attributes?"

2. WHAT IS SPAM?

SPAM is an example of a query technique. The logic of query technique is that SA is reflected in the ability of operator (student) to answer questions about the situation they are, or have been controlling or managing [2].

Using SPAM techniques [5], slightly modified in this paper, students after they have learned the appropriate text, are asked individual questions in the course of a scenario while performing normal tasks. According to publication [2], either task-relevant SA information is held directly in memory or the location of this information is held in memory. Therefore, in SPAM, SA is measured as both the number of correct responses and the time to answer the question correctly. If the information being queried is held in the student's memory, he or she can respond quickly. If the information is not in memory, but available in the text,

response time will be faster if the student knows where to find the information.

To separate the effects of workload from SA, the student is usually asked if he/she is ready for a question, and the question is not asked until the student responds affirmatively to the ready prompt. The time interval between the ready prompt and the student's acceptance is taken as a measure of workload, see Figure 1. The questions must be presented in a manner to be consistent with the text.

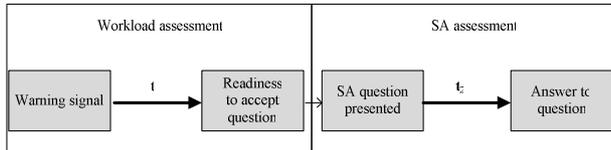


Figure 1 Illustration of SPAM technique

Here t_1 is time to assess the workload and t_2 is SA assessment.

Briefly, following [2], students are presented queries about the situation described in the text while the situation remains present and while they continue to the primary task. Response time in addition to accuracy is recorded. Response time should vary with the level of SA. For example, if the student has an answer to the query in active memory, response time should be short. If the student needs some evaluation of the particular value, then response time should be slower. Still slower would be a student who did not know where to look for an answer.

The technique is intended to measure comprehension when the situation remains present. Frozen chess situation can help us to construct such kind of query. In principle, in the paper we propose to use text as an equivalent to present chess situation and not to assess the workload by t_1 .

SA assessment within the limits of the concrete text fits the ideology of open-book exam, i.e. the student has the studied text, which is at his/her hand and can use it while answering questions. Moreover, according to SPAM ideology, the student should carry out any task related to the studied material, but here we will be limited only to an assessment of the studied text.

There are some techniques of assessment of SA levels, but we use the SPAM technique for the following reasons [2]:

- SPAM's use of response time promises to provide more statistically sensitive measure rather than accuracy as is usually the case when both accuracy and speed are recorded in the same cognitive task.
- SPAM's use of response time allows researchers to assess when it succeeds rather than only when it fails.
- SPAM is consistent with the pre-theoretical position that understanding of a situation is best accomplished when the situation is present and the operator (student) is engaged.

In a lot of cases, it may be more efficient to know where to find information, than it would be to use limited cognitive resources to remember it.

3. CONCEPTUAL MAP OF THE TEXT

We define the *situation* as a combination of key concepts logically connected between them in space of the text studied by the student, causing a certain information picture which induces mental activity of the student. This picture can be presented visually by means of a conceptual map.

The principle of construction of a conceptual map is presented in Figure 2.

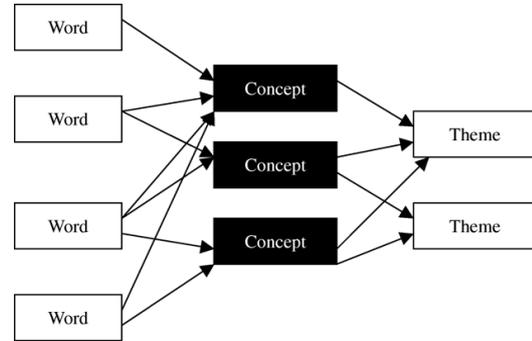


Figure 2 Leximancer concept map construction

The information is displayed by means of a conceptual map that provides an overview of the material, represents the main concepts contained within the text. Their relations are also presented. It is assumed here as an equivalent of chess situation.

A map produced by Leximancer software for Chapter 1 "Introduction to Marine Navigation" [4] is shown in Figure 3.

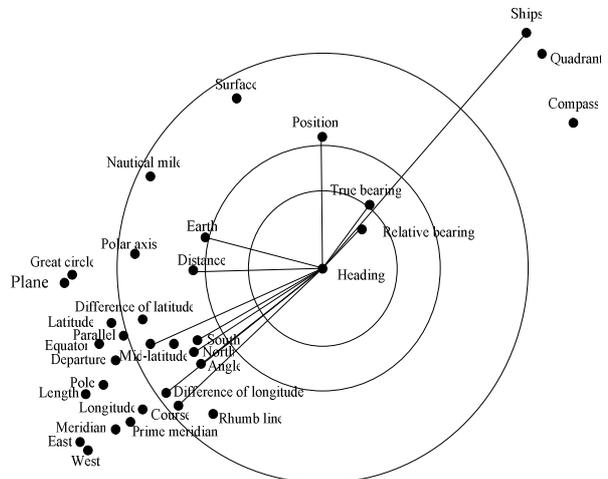


Figure 3 Leximancer conceptual map for Chapter 1[4] "Introduction to Marine Navigation"

Following [2], we philosophically compare a situation which is caused by the text with a chess situation which is described by relative positioning of pieces. In other words, we put in conformity the chess situation, which induces the player to certain actions, and a situation constructed by concepts of the text, which also induces the student to certain mental activity.

For example, the relevant SA questions that can be put to chess player to assess if he/she is aware of the

present situation are [2]:

Level 1 SA: Where is the white queen?

Level 2 SA: What piece is the white bishop attacking?

Level 3 SA: What piece can white move to pin black's rook?

The analogical questions for the text can be as follows:

Level 1 SA: Show the key concepts in the text you have learned;

Level 2 SA: Are there any contextual relations between concept 1 and concept 2 in the text?

Level 3 SA: If some attributes of concept 1 are altered, how does it affect the concept 2?

When the student has learnt the text and perceived the conceptual map, his/her self assessment positive results can be as follows:

- I can identify the main concepts in the text.
- I understand the relations between these concepts.
- I can predict changes in the attributes of a certain concept if the attributes of others are changed.

Having applied the Leximancer software for Chapter 1[4] "Introduction to Marine Navigation", as an example, we have received the conceptual map where the concept Heading is statistically and contextually linked with some other ones, Figure 3. Map shows the relative location of concepts of the text and defines the certain contextual situation. Statistical relations existing between concepts are marked by springs of various lengths. The closer the concepts locate to each other, the more similar they are contextually. It gives the teacher a key for designing questions of various complexities, using also the hidden intra-text information.

Below there is a possibility to compare some text selections, which includes the concept *Heading* with the locations of appropriate concepts related to *Heading* on the map:

Concepts: *Heading* and *Relative Bearing*

Text selection 1: "A *Relative Bearing* is measured relative to the ship's heading from 000° (dead ahead) clockwise through 360°. However, it is sometimes conveniently measured right or left from 0° at the ship's head through 180°. This is particularly true when using the table for *Distance of an Object by Two Bearings*. To convert a *Relative Bearing* to a *True Bearing*, add the *True Heading*: $True\ Bearing = Relative\ Bearing + True\ Heading$ ", [4]. The spring between these two concepts is short, and the relation between them is direct and simple.

So, the questions for SA assessment can be the following:

- Show me where in the text you can find the term *Heading* (SA1)
- Can you find the relations between two text concepts as *Heading* and *Relative Bearing* (SA2)?
- The ship is moving but the *Relative Bearing* to the lighthouse is constant, what can you say about the value of *True Heading*, (SA3)?

Concepts: *Heading* and *True Bearing*

Text selection 2: "*Heading* (Hdg., SH) is the direction in which a vessel is pointed, expressed as angular distance from 000° clockwise through 360°. Do not confuse *Heading* and *Course*. *Heading* constantly

changes as a vessel yaws back and forth across the course due to sea, wind, and steering error. *Bearing* (B, Brg.) is the *direction* of one terrestrial point from another, expressed as *angular distance* from 000° (North) clockwise through 360°. When measured through 90° or 180° from either *north* or *south*, it is called *bearing angle* (B).", [4].

This concept also locates very close to the concept *Heading*. It means that they are also contextually similar, that is why SA assessment questions can be the easiest, like in the first case.

The next pair of concepts locates at longer distances on the conceptual map due to their contextual relations and are more complex and less specified; that is why the understanding of these relations requests more workload.

The following extracts from the text were used by Leximancer to produce the relation springs between concepts *Heading* and *Middle Latitude*:

Heading and *Middle Latitude*

Text selection 3: "Do not confuse *Heading* and *Course*. *Heading* constantly changes as a vessel yaws back and forth across the course due to sea, wind, and steering error", [4]. The concept *Middle Latitude* does not exist in this text selection, but Leximancer identified the link, which means that there are relations between these concepts.

Possible questions:

- Show the concepts *Heading* and *Middle latitude* in the text (SA1)
- Is it possible to identify their relations? (SA2)
If to peruse the text, the logical chain can be identified between these concepts. This chain is *Heading* – *Course* – *Difference of Latitude* – *Difference of Longitude* – *Departure* – *Mid Latitude*. Here *Departure* is the connecting link. Why not it looks like a chess combination? The third question might be as follows:
- How will the *Course* (*Heading*) of the ship be altering if *Difference of Latitude* between two consequent way points is approaching to 0°? (SA3).

More complex relations between the concepts *Heading* and *Middle Latitude* were identified by Leximancer in text selection 4: "The sailings refer to various methods of mathematically determining *course*, *distance*, and *position*. They have a history almost as old as mathematics itself. Thales, Hipparchus, Napier, Wright, and others contributed the formulas that permit computation of *course* and *distance* by plane, traverse, parallel, *middle latitude*, Mercator, and great circle sailings." Try to put three questions using SA approach for above concepts.

The next selections were automatically identified by Leximancer to show the complex relations between the concepts *Heading* and *Difference of Longitude*.

Concepts: *Heading* and *Difference of Longitude*

Text selection 5: "*Heading* (Hdg., SH) is the *Direction* in which a vessel is pointed, expressed as *Angular Distance* from 000° clockwise through 360°. Do not confuse *Heading* and *Course*. *Heading* constantly changes as a vessel yaws back and forth across the *Course* due to sea, wind, and steering error. *Bearing* (B, Brg.) is the *Direction* of one terrestrial point from

another, expressed as *Angular Distance* from 000° (North) clockwise through 360°. When measured through 90° or 180° from either *North* or *South*, it is called *Bearing Angle* (B), [4]”.

The contextual chain here is *Heading – Course - Difference of Latitude - Difference of Longitude*.

Text selection 6: “The *Difference of Longitude* (DLo) between two places is the shorter *arc* of the parallel or the smaller *angle* at the pole between the meridians of the two places. If both places are on the same side (*east* or *west*) of Greenwich, DLo is the numerical difference of the *longitudes* of the two places; if on opposite sides, DLo is the numerical sum unless

4. CONCLUSIONS

The importance to develop and research the SA assessment techniques in MET is obvious and SPAM in this case, by our opinion, has some advantages:

- SPAM is the measuring tool and it gives the chance to assess the levels of SA quantitatively and objectively.
- By means of SPAM the additional information to correctness and accuracy of student answers is assessed. It is t_2 - the time between question presented and student answer.
- The SPAM assessment results are suitable for statistical processing and can be applied for improvement of MET procedures.
- Application of Leximancer software allows easily to create a conceptual map of the text. It gives the student an opportunity to observe the basic concepts, and helps the teacher to design SA set of questions designed on these concepts. The Leximancer software is attractive tool for designing the open-book SA exam questions based on several texts.

this exceeds 180°, when it is 360° minus the sum. The *distance* between two meridians at any parallel of *latitude*, expressed in distance units, usually nautical miles, is called *departure* (p, Dep.). It represents *distance* made good *east* or *west* as a craft proceeds from one point to another. Its numerical value between any two *meridians* decreases with increased *latitude*, while DLo is numerically the same at any *latitude*. Either DLo or p may be designated *east* (E) or *west* (W) when appropriate” [4].

Try to find common words in text selections 5 and 6, which help you to make three SA queries.

5. REFERENCES

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