# CLIL and Its Possible Application to Engineering Education to Enhance Undergraduates' Academic and Subject-specific English Literacy

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**Abstract:** Amid the ongoing discussion on the optimal acquisition of academic and subject-specific English literacy to prepare learners for participating in a global society, content and language integrated learning (CLIL) has been attracting a lot of attention recently. CLIL is a dual-focused educational approach to teach and learn subject and language simultaneously using an additional language such as English as a second language. CLIL as a teaching methodology allows flexibility: soft or hard (language teaching oriented or subject teaching oriented) and light or heavy (sporadic implementation during the course or regular implementation during the course) according to the purpose of the course and cognitive and language demands of the learners. Set in the context of a provincial national university this paper considers the effective implementation of light CLIL to create optimal conditions for acquiring English for Engineering students with an English proficiency level ranging from beginner to lower-intermediate. In addition, the application of CLIL to engineering education is discussed through examples of recent engineering CLIL classes conducted in support of engineering teachers.

***Key-Words:*** *CLIL, Interdisciplinarity, Global Human Resources Development, Engineering Education*

## 1. Introduction

In the pursuit of the declared EU linguistic policy that most European citizens learn at least two foreign languages in addition to their mother tongue, the European Commission was searching for the most effective educational practice. It was the 1995 Resolution of the Council, one of the first pieces of legislation, which stipulated European cooperation in Content and Language Integrated Learning (CLIL) [10]. CLIL is a dual-focused educational approach to teach and learn subject and language simultaneously using an additional language (e.g. English as a second language) [6].

In the midst of rapid socio-economic change, CLIL has also captured global attention since, in contrast to the teaching approach that emphasizes the maxim, *learn now for use later*, CLIL caters for a desire to *learn as you use, use as you learn* [6].

This paper discusses the implementation of light CLIL (sporadic implementation of CLIL during a course for Engineering undergraduates) in engineering education, particularly by utilizing experiential learning classes which are associated with the relevant engineering lectures. First, CLIL methodology and principles are introduced based upon a review of relevant literature. Then, the application of the CLIL methodology in the civil engineering experiential learning classes is outlined along with samples of materials developed in collaboration with the engineering teachers. Considering the low linguistic demands of students in this teaching context, three essential ideas need to be borne in mind: (1)

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implementing light CLIL following and followed by the associated lecture utilizing the mother tongue, (2) relating the small experiment using realia to the resulting phenomenon described in graphs, and (3) gradual removal of linguistic and cognitive support in the sequence of the tasks. In the final section, those three essentials are elaborated upon, and the paper concludes the application of light CLIL to engineering undergraduate education.

## 2. CLIL methodology and principles

### 2.1 The 4Cs framework

"The 4Cs framework", as shown in Fig.1, demonstrates the interrelationship of the fundamental CLIL constructs between content (subject/topic), communication (language), cognition (learning and thinking), and culture (intercultural awareness) [4]. The framework considers content and language to be intermediaries of other components: content as an attribute to the domain of "knowledge for learning" (integration of content and cognition) and language as a medium for learning (integration of communication and intercultural understanding) [5]. Cognition in CLIL entails integration of a variety of thinking and problem-solving skill development to content learning. Therefore, not only lower-order thinking (remembering, understanding and applying) but also higher-order thinking (analyzing, evaluating, and creating) is vital for effective learning [6]. Culture plays an essential role in the interaction between language and thought since culturally specific viewpoints are embedded in language [3]. Therefore, deeper understanding of cultural perspectives can be cultivated through the utilization of appropriately designed authentic materials, which in turn, encourages learners to better envision their future selves in a multi-lingual and global society [6].

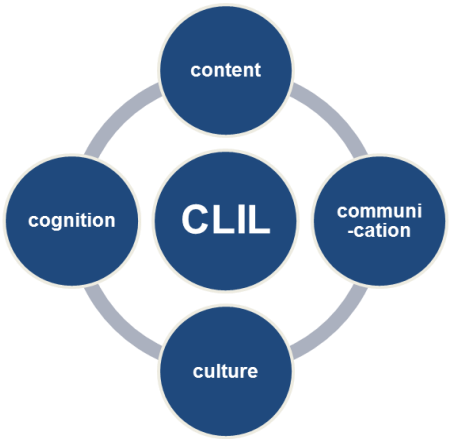


Fig. 1 Schematic representation of *the 4Cs framework*

To respond to differing cognitive and linguistic demands of learners in CLIL lessons, it has been suggested that "the CLIL Matrix" helps balance the cognitive and linguistic demands, which can be seen in Fig.2 [6]. The matrix is also helpful for CLIL teachers to plan and evaluate activities considering the learners' progress. Quadrant 1 in the matrix contributes to enhance initial learner confidence, which facilitates learner transition to quadrant 2. Successful progress in language learning whilst maintaining cognitive challenges will move the learners systematically over time to quadrant 3. However, learners' progress is not always successfully and steadily accomplished like the representation in quadrant 3. Due to high linguistic demands, quadrant 4 can be optimally exercised so long as linguistic practice and focus on form are vital for the learners' progress in CLIL lessons [6]. For example, after realizing that the learners' ability to cope with complex or challenging tasks is not satisfactory, teachers may choose to lower cognitive demands of the tasks but still encourage advanced language learning. This can be done by using focus on form (of language), which facilitates and solidifies linguistic aspect of learning. Therefore, the matrix will help teachers decide which quadrant to be selected for designing the lessons according to students' learning progress.

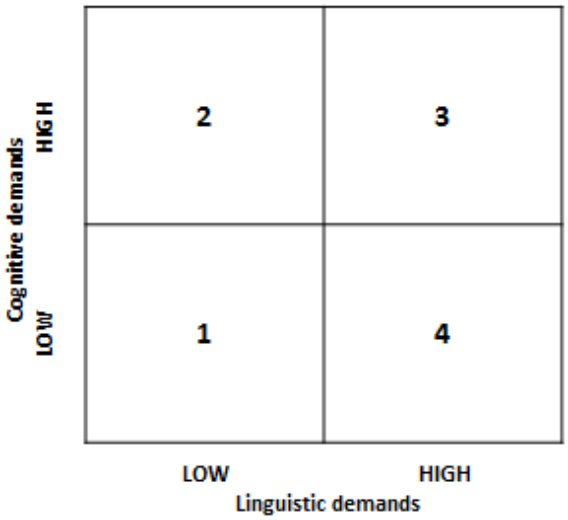


Fig. 2 The CLIL Matrix (adapted from Coyle, Hood, and Marsh, 2010: 43)

## 2.2 Active learning and tasks

CLIL involves active learning so as to engage learners in the learning process through activating learners' prior knowledge, cooperative learning, and self- and peer-assessments. Active learning in this paper is defined as anything that "involves students in doing things and thinking about the things they are doing" [2]. To foster learners' active involvement, their engagement in higher-order thinking tasks such as analysis, synthesis, and evaluation is essential [2]. Tasks in the second language acquisition (SLA) are viewed as (1) classroom activities/exercises involving goals which can be only accomplished by learner interactions, a mechanism for designing interactions, and a focus on meaning exchange; (2) language learning endeavors requiring learner comprehension, manipulation, or the target language production whilst addressing some set of work plans, or both [12]. Therefore, tasks in CLIL promote active learning amongst learners through effectively structuring learning opportunities. Tasks in SLA can be classified into six types: listing, ordering and sorting, comparing, problem-solving, sharing personal experiences, and creative tasks [15]. This classification is a useful reference for designing tasks in CLIL according to the cognitive and linguistic demands that CLIL teachers aim to embed.

### 2.3 Flexibility of CLIL

As shown in Fig.3, CLIL allows flexibility: soft or hard (language teaching oriented or subject teaching oriented), light or heavy (sporadic implementation during the course or regular implementation during the course), partial or total (partial implementation in class or full implementation in class), bilingual or monolingual (English and Japanese or English only) according to the purpose, frequency, ratio and medium of language of the course [11].

CLIL also affords *translanguaging*, which refers to "the adaption of bilingual supportive scaffolding practices" [8]. It is a co-use of both learner's first language (hereafter, L1) and second language (hereafter, L2) to accomplish tasks and understand and convey meaning [1]. The learners in the lower English proficiency class at a Japanese university demonstrated increased positive perception regarding their L1 use and teacher's L1 metadiscourse to inform tasks and expected outcomes. This contributed to reduce the least proficient learners' anxiety and caused more focus on the tasks per se rather than the metadiscourse [1].

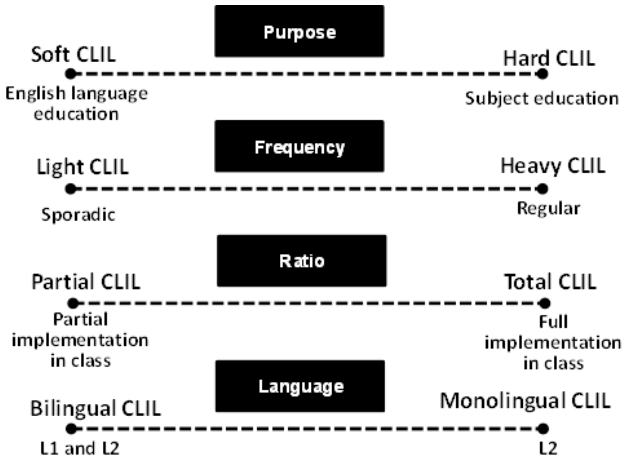


Fig. 3 Variations of CLIL (adapted and translated from Ikeda, 2011)

### 2.4 Motivational factors of CLIL

Authenticity is one of the key terms in CLIL, and it is considered that increased authenticity will bring about enhanced engagement and motivation in the learning [13]. Authenticity can be categorized into three components: authentic texts, authentic tasks, and authentic language in use. Generally, authenticity tends to signify materials for student interactions and language input, but it may also refer to the tasks that the teacher implements as a means of engaging with or experiencing the content such as the use of authentic English newspapers in authentic manners. Authentic language in use represents classroom student-student and teacher-student interactions. CLIL classes are more inclined to involve *translanguaging* as students' cope with their learning content and negotiate comprehension, which can be naturally seen in bilingual speakers [13].

The other motivational factor of CLIL derives from the affective facets of cooperative learning. Cooperative learning is characterized as the pedagogic use of small groups (3 to 6) to attain shared learning goals via cooperation [9]. Affective domain of cooperative learning includes positive attitudes toward learning, increased motivation, better teacher-student and student-student relationship associated with more developed interpersonal skills and higher self-esteem perceived by the students [9].

## 3. Possible application of CLIL to engineering education

### 3.1 Proposed teaching conditions

First, this section proposes and discusses several teaching conditions for CLIL to be effective especially in the civil engineering field by reflecting upon the light CLIL pilot implementation conducted by the language teacher in collaboration with the engineering subject teacher, and the language teacher's observation of the subsequent experiential learning classes conducted by the engineering subject teacher. Then, the possible application of the light CLIL will be discussed using an outline of a proposed lesson plan.

The proposed CLIL lesson plan is aimed at an undergraduate civil engineering experiential learning class at a university where the majority of learner English proficiency level is beginner to lower-intermediate. However, the sequence of the lesson design and examples of CLIL fundamentals suggested in this section are not limited to the civil engineering, but will be of help to any engineering discipline. To facilitate CLIL implementation, applying CLIL in the experiential learning classes is considered to be the most practical. Typically, at Japanese universities, some compulsory subject lectures entail the relevant experiential learning classes, which the students are expected to take in addition to those lectures to clarify, solidify, and apply their learning. Therefore, the experiential learning classes would fit the purpose of CLIL and can also be flexible enough to pilot new instructional approaches. Light CLIL will be beneficial for students with lower language proficiency levels since sporadic implementation of CLIL lesson allows the engineering subject teacher to refer back to the English content of the CLIL lessons as appropriate in his/her L1 in the continuum of the course. This subject teacher's L1 instruction following the CLIL lesson will encourage the lower language proficiency students' enhanced learning. This light CLIL posits three important points that need to be covered prior to the CLIL lesson in the experiential learning classes: (1) the L1 lecture conducted by the subject teacher (2) the students' preview of bilingual keyword list prepared by the language teacher (3) collaborative lesson design by the subject teacher and the language teacher. The CLIL lesson can be taught by the subject teacher solo, the language teacher in the presence of the subject teacher, or subject teacher and language teacher teaching

collaboratively. Nevertheless, due to the necessity of abundant language scaffolding to the lower level language proficiency students, this paper would suggest the language teacher's instruction in the presence of the subject teacher. That way, the subject teacher can intervene as necessary.

### 3.2 The 4Cs to be incorporated in the lesson

Table 1 summarizes the 4Cs which needs embedding in this proposed CLIL lesson.

Table 1 The 4Cs for the proposed civil engineering CLIL

| Content | *consolidation* (civil engineering) |
|---|---|
| Communication (Language) | ● conditional (grammar)<br>● key terms related to *consolidation* such as *pore water pressure* and *effective stress*<br>● language used for describing graphs, oral presentations, and mathematical equation |
| Cognition | Hypothesizing (inference) |
| Culture | ● The leaning tower of Pisa<br>● Typical academic discourse used in the literature of soil mechanics |

Whilst discussing the engineering subject teacher, the language teacher found the theme of *consolidation* reasonably applicable to the content of CLIL since, as demonstrated in the next section, mastery of conditional clause and language used for describing graphs, oral presentations, and mathematical equation will be closely-intertwined with the successful completion of the proposed tasks from a linguistic viewpoint. *Consolidation* is the term in soil mechanics, which refers to "any process which involves a decrease in water content of saturated soil without replacement of water by air" [14]. The notion of *consolidation* can be used to explain what mechanism caused the leaning tower of Pisa to lean. Therefore, the task will include: the skills of hypothesizing and inferencing by asking the question, "What mechanism caused the leaning tower of Pisa to lean?", which may develop learners' higher-order thinking and intercultural awareness nurtured by the authentic material.

### 3.3 Suggested activities

#### 3.3.1 Goal setting

The CLIL lesson starts with demonstrating the shared learning goals on the presentation slide as follows. By the end of this class, students will be able to: (1) explain the process of *consolidation* using *the model of consolidation* (2) understand the concept of the key terms in English and use them. It is crucial that the learners be conscientious of learning objectives explicitly at the beginning of the class since the learners' awareness of what they are learning for may provide momentum for learning towards the self- and peer assessments they are engaged at the end of the lesson.

#### 3.3.2 Activating learner prior knowledge

The students are supposed to have learned the *consolidation* in the L1 lecture at a certain point prior to the CLIL lesson and have previewed the bilingual keyword list. At this stage, the definitions of the three fundamental terms *pore water pressure*, *total stress*, and *effective stress* are presented on the presentation slide. The students need to read them individually, guess what each key term is, and share their thoughts with their classmates. The teacher should monitor their discussion and have a strong student answer.

The next slide should include the picture of the leaning tower of Pisa with the following comprehensible discussion questions. (1) "Did this phenomenon happen within a short or long period of time?" (2) "Why do you think this phenomenon happened within a short or long period of time?" Taking the leaning tower of Pisa as an example will facilitate learner understanding of the *consolidation* and motivate the students in terms of the capacity of the authenticity.

#### 3.3.3 Using realia: a model of consolidation

Suggested by the engineering subject teacher, if possible, using the realia such as the *model of consolidation* (see Appendix 1) to demonstrate the simplified mechanism of *consolidation* will be helpful. After checking each part of the *model of consolidation* in the whole class in English, have the students form their hypothesis of the following two cases. (1) The valve is fully closed. (2) The valve is half-open. This task will help develop learners' higher-order thinking. Some keywords are shown on the slide to scaffold the students' spoken and written output (see Appendix 2).

Call upon some volunteer students to enjoy manipulating the model in front of the class: placing the weight on the top of the model. Then, the students will witness what will happen to the piston, the amount of the water inside the burette, and the pressure gauge in the following two cases. (1) The valve is fully closed. (2) The valve is half-open. This experimental component involves authenticity, and consequently enhances learners' motivation, captures their attention, and promotes active learning.

**3.3.4. Think, pair, share**

As one of the active learning repertoires, *think, pair, share* is often used in English language education. The basic idea of this sequence of activity is, in response to the teacher's question, the students are provided with time to (1) think individually, (2) discuss their thoughts in pairs, and (3) share their ideas with everyone in class [7].

In this suggested activity, according to their discovery in the experiment, the teacher should have the students fill in the blanks individually (see Appendix 3). Then, the students should discuss their answers with their neighbor, with more classmates in groups and the whole class, in turn. In so doing, the students will be able to process the language and content more thoroughly, gain confidence, and participate actively in the task. The teacher should have the students move on to a slightly more challenging task which is visually scaffolded to facilitate the students' spoken output (see Appendix 4). Finally, the students need to discuss to relate the experimental result to the actual phenomenon occurred to the leaning tower of Pisa using Appendix 4 and should match the tower and clay in the soil to the appropriate pictures. It is aimed at enhancing learners' understanding of the mechanism of the *consolidation* with authenticity.

**3.3.5 Active listening task on consolidation**

The students need to engage in active listening to the teacher's short lecture on *consolidation* demonstrated in line graphs (see Appendix 5). This task is designed to associate the result from the experiment using *the model of consolidation* with the graphical representation of the three differing stresses over time: *total stress, pore water pressure*, and *effective stress* according to the aforementioned two cases.

**3.3.6 Self-, peer-assessments, and oral presentations**

To reflect upon the CLIL lesson, the students should engage in the self-assessment by filling in the blanks (see Appendix 6). Then, the students need to discuss if their answers are correct with their neighbor in pairs. The teacher elicits answers from the class and the students check and correct their answers. The teacher should have the students rehearse oral presentations using the information in the self- and peer-assessments to reinforce their understanding. The students are provided with visually scaffolded material for their oral presentation (see Appendix 7). The oral presentation should be performed in small groups so that the students can gain immediate feedback from their peers.

## 4. Conclusion

This paper has explored the fundamentals of CLIL – methodology, principles, and motivational factors – and then has discussed the application of light CLIL for

engineering undergraduates, whilst discussing its benefits in light of the positive interdisciplinary collaboration for the pilot civil engineering experiential learning classes between the civil engineering teacher and the English language teacher. To sum up, despite the variety of ways to implement CLIL, particularly for engineering classes in which the majority of learners' English proficiency level is beginner to lower-intermediate, the following three ideas are crucial: (1) implementing light form of CLIL following and followed by the relevant L1 lecture, (2) relating the small experiment using realia (e.g., *the model of consolidation*) to the resulting phenomenon illustrated with graphs (e.g., changes of *total stress, pore water pressure,* and *effective stress* over time), and (3) gradually removing linguistic and cognitive support as students progress a series of tasks. The first is aimed at the low linguistic demand of the students. The prior L1 lecture will help the students discover links between the knowledge in their L1 and L2. Furthermore, the subsequent L1 lecture by the engineering subject teacher is expected to posit the knowledge from the last class, by which the engineering subject teacher can touch upon and review the content of the CLIL class in the L1. This L1 intervention will help solidify the students' comprehension. The second concerns the motivational factor in engineering education. Experimental components involved in engineering education can be an advantage for engineering students' enhanced motivation. When deciphering the resulting phenomenon using the graphic representation, the students' learning is visually aided, and thus the students' L2 comprehension will be facilitated. The third indicates the two strands of task sequence according to the stage of the CLIL lesson. One is the sequence during the lesson: demonstration of the keywords and speaking frame in which the students are required to fill the keywords, followed by the speaking task using the speaking frame only, and then visual cues only for more natural spoken output. The other is the sequence at the end of the lesson: the self-assessment requiring only lexical challenges, followed by the peer-assessment involving negotiation of meanings and metalinguistic explanation to the classmate, and then oral presentations to group members entailing L2 processing during the rehearsal and the actual delivery of the presentation.

Nevertheless, a series of suggestions are still limited to the reflection upon the pilot CLIL implementation in the civil engineering experiential learning classes. It is hoped that more extensive application of CLIL methodology throughout the course and students' genuine voice regarding the light CLIL implementation will be quantitatively and qualitatively examined to investigate its educational efficacy in the future research.

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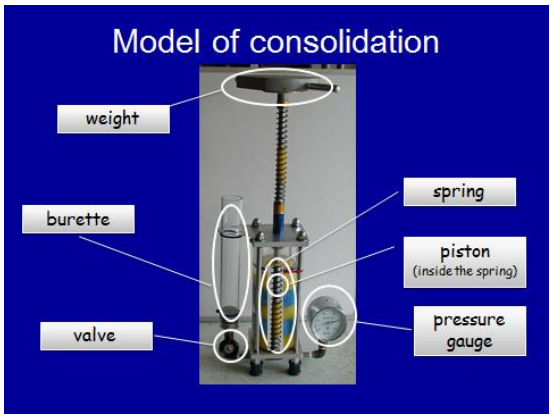
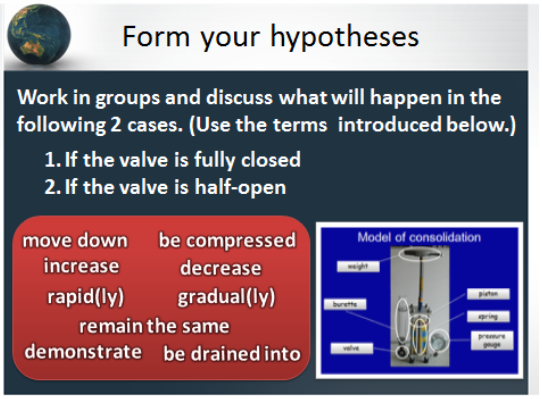
## Appendix

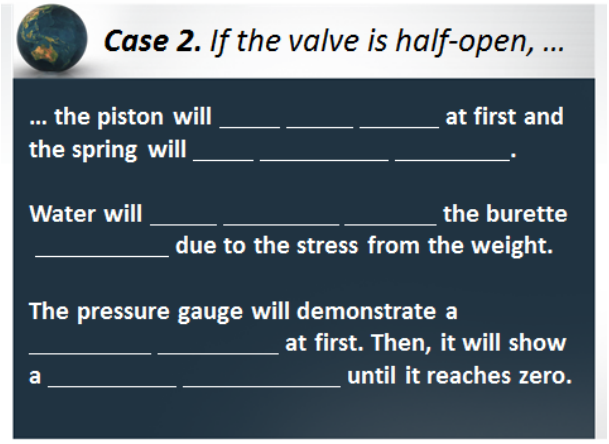
Appendix 1 Presentation slide 1: The model of consolidation



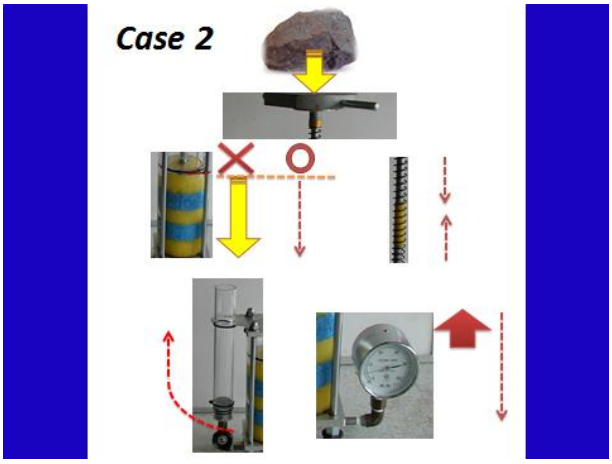

Appendix 2 Presentation slide 2: Keyword list and hypothesizing task



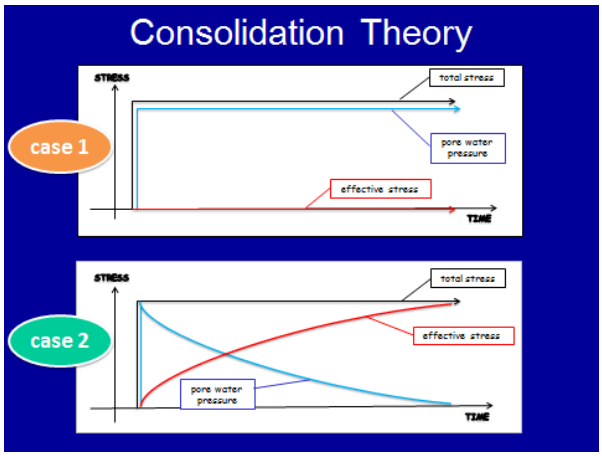

Appendix 3 Presentation slide 3: Speaking frame for *think, pair, share*



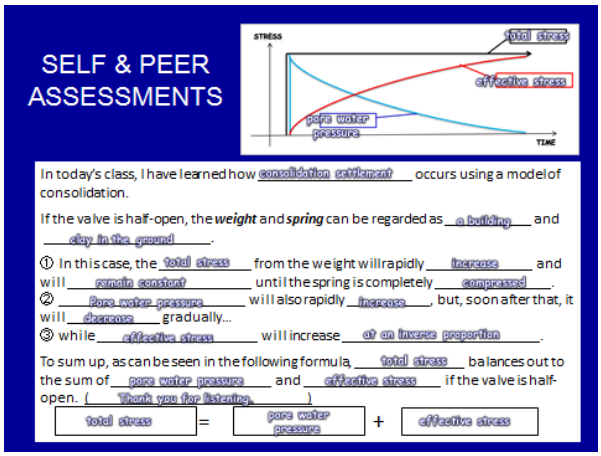

Appendix 4 Presentation slide 4: Visual cues for spoken output



Appendix 5 Presentation slide 5: Graphical representation of the changes of *total stress*, *pore water pressure*, and *effective stress* over time




Appendix 6 Presentation slide 6: Self-assessment sheet




Appendix 7 Presentation slide 7: Visually scaffolded material for the students' oral presentation task