Looking for Evidence of Deep Learning in Constructively Aligned Online Discussions

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ABSTRACT
Building upon previous work by the authors, this paper describes a small-scale study that involved analysing the depth of thinking evident within asynchronous discussion contributions. The discussion tasks in question, which were undertaken within the context of a fully online distance course, were designed according to the principles of constructive alignment, and analysed using the SOLO taxonomy. Of particular interest within this study was whether the SOLO taxonomy would provide evidence of surface-to-deep or deep-to-deeper learning having occurred on an individual basis over time, and also how suitable the SOLO taxonomy was as a tool for the content analysis of online discussions. Findings on both counts were encouraging, but not unproblematic.

KEYWORDS
Constructive alignment, online discussion, deep learning, content analysis

INTRODUCTION
Asynchronous online discussion offers much that could potentially support effective communication and collaboration between students. The medium provides an opportunity to reflect upon, research and articulate thoughts in a way that does not exist in face-to-face seminars, and is one in which a few more forthcoming individuals are less likely to dominate discussion at the expense of their fellow learners (Mason, 1994).

It is thought, and there is some evidence, that the increased reflection enabled by asynchronous discussion can lead to a more informed, critical exchange of views than is sometimes possible in real-time dialogue (Newman et. al. 1996, 1997; Vaughan & Garrison 2005). Yet there is also evidence to suggest that online exchanges can sometimes lean more towards descriptions of personal experience than well-supported, subject-related reasoning (Angeli et al 2003). A critical factor here is task. Without having appropriate activities in place to provide a purpose and structure to online communication, then effective, reflective engagement between students is unlikely to occur (Tolmie & Boyle 2000; Salmon 2002). In fully online contexts with no opportunity for face-to-face interaction then, the need for suitable discussion tasks therefore becomes a particularly critical concern.

In recent years Biggs (1996, 2003) model of 'constructive alignment' has increasingly been used by course designers to articulate and strengthen the relationship between learning objectives, teaching methods and assessment. Biggs (2003) proposes that effective constructive alignment can lead to learning tasks, and corresponding forms of assessment, that are more likely to encourage 'deep' learning that is characterised by the student being focused on understanding, and involves the development of conceptually rich knowledge that provides the basis for learning in new contexts. This is the opposite of 'surface' learning in which the student attends only to basic facts and principles, and fails to integrate them in a meaningful manner. Yet despite the clear potential of the approach, to date only a few applications of constructive alignment within online teaching and learning have been described in the literature (e.g. McLoughlin, 1999, Hall 2002, Talay-Ongan 2003).

In an extension of previous work by the authors (Mainka et al 2005), this paper describes an application of the SOLO taxonomy (Biggs & Collis, 1982) to analyse the quality of understanding evident within the contributions of students who undertook a series of constructively aligned online discussion activities within a fully online, upper level undergraduate distance learning course. Two issues of particular interest in this small-scale study concerned the suitability of the chosen tool for the aforementioned purpose, and whether the discussion contributions of individual students would yield any evidence of them moving from a surface-to-deep or deep-to-deeper approach in their thinking and understanding over time, in response to the tasks undertaken.

SOLO TAXONOMY

The SOLO (Structure of Observed Learning Outcomes) taxonomy was developed as a result of Biggs and Collis' (1982) research into the variation in the structure of learning outcomes. The SOLO taxonomy is designed to be applied to verbal and written learning outcomes, and describes five levels of learning outcome ranging from the most simple, or least sophisticated, through four other increasing stages of understanding. In order the five stages are termed Prestructural, Unistructural, Multistructural, Relational, and Extended Abstract.

The taxonomy is seen as a systematic way of categorising, or classifying, the increasing complexity encountered by learners when learning academic tasks, as well as defining curriculum objectives which describe the various levels that students should be working at, or for evaluating actual levels at which students are working (Biggs, 2003). At the Prestructural level (P), students have missed the point and the response bears little or no relation to the task in hand. The other four levels are seen to consist of two increasingly complex stages that are thought to reflect Marton and Säljö's (1976) two approaches to learning. Unistructural (U) and Multistructural (M) are more associated with a quantitative increase in knowledge or 'surface approach' to learning where one piece of information, fact etc is used or identified (U), or where more than one piece of information is identified, but each is used separately with no integration (M). This is in contrast to the Relational (R) and Extended Abstract (EA) levels which are considered more akin to the 'deep approach' to learning which is associated with the quality of understanding or thinking. For example, at the (R) level, integration of at least two pieces information is required in order to answer a question or to complete a task, and at the (EA) level, students are expected to go beyond the information that is supplied in order to create a hypothesis or to predict (Hattie and Brown, 2004).

There are various ways of analysing student engagement with subject matter and each other in online discussion, and various tools exist for doing so based on critical thinking, levels of argumentation, and the extent of collaborative discourse vs. individual communication (De Wever et al, 2006, provide an excellent overview in this area). However, as the SOLO taxonomy is an important element within Biggs's work on effective teaching and learning, it seemed the most appropriate tool to analyse the depth of understanding within discussions that were the result of constructively aligned activities. This also provided the opportunity to assess the usefulness of the taxonomy for analysing online discussions – a purpose to which it has rarely been applied.

CASE STUDY

The course in question was an upper level undergraduate, fully online module offered by the University of Maryland University College's (UMUC) European Division to an international audience of adult learners. It was taught by one of the authors intermittently from 2000-2004 with an average of 20-25 students per course. Running over 14 weeks, the module was delivered in 6 units supported by a wide range of offline and online learning activities. Learning objectives, activities and assessment were designed according to the 'constructive alignment' model by Biggs (2003) in which it is recommended that in order to encourage deeper levels of understanding, teaching and assessment methods be practiced that support the explicit objectives of the course. A fuller explanation of constructive alignment as it was applied to this course is given in Mainka et al (2005).

The majority of the teaching and learning took place collaboratively in the weekly asynchronous Thought Conferences. Each week a series of open-ended Thought Questions carefully aligned to a specific learning outcome were assigned. The questions were designed to promote interaction through involving a case study or authentic problem-based inquiry, and encourage understanding of a higher order through the student applying their developing understanding to the real world. The student could choose which of the questions they would tackle each week, and the majority of learners became actively engaged with their peers and the available resources in the process of creating knowledge. This was supported both by the tutor in a facilitating and co-learning role, and by discussion assessment criteria that emphasised the quality not quantity of contributions.

ANALYTICAL PROCEDURES

Based on a random sample of 9 students from a class of 23, whole asynchronous conference messages for five out of twelve weeks of the course were chosen as units for analysis. Not all responses could be accounted for via the SOLO taxonomy, and this resulted in the addition of a category 'C' to reflect confirmatory student responses (where a confirmation of a fact or opinion was either sought or offered). The three authors, as coders, classified the complete sample of discussion messages individually before comparing findings. Inter-rater reliability, where two or more coders agreed with one another (De Wever et al, 2006) in classifying the same contribution against the same category in the SOLO taxonomy was measured at 93%. Only in a small number of instances did one or more of the authors categorise a response at more than one SOLO category apart.

The following examples demonstrate the identification process applied for each level. In the first example students responded to the question at a Prestructural, Unistructural and Multistructural level as demonstrated:

> *Thought question: What does your tunafish sandwhich have to do with biodiversity?*

At the Prestructural level students engage with the task but show little or no understanding. In the following, the student responds, but does not respond directly to the question in a meaningful or coherent way:

> *R1: "Everything that we eat is connected somehow. The earth offers the different types of nutritional diversities which is how a tuna fish would come into play. Fish is one of the diverse foods on earth that play a role in our develop."*

At the Unistructural level some understanding is evident, but the focus of the response to the same question resides on one piece of information or issue (in this case, a focus on food chain):

> *R2: "My tunafish ate mackerels and herrings, which in turn fed on dozens of species of smaller fish, such as crustaceans, squids, worms, and plankton. So my tunafish was or could have been biodiversity account for at least 50 species of animals as food. The bottom line is that biodiversity is the basis upon which ecological systems operate. One or two species lost may not seem a problem, but within a certain species that's crucial…"*

At the Multistructural level the student addresses multiple issues affecting biodiversity (consumption habits)*:*

> *R3: "Biodiversity sustains the environments in which we live and on which our lives and those of every other live creature on Earth depend upon. Because of biodiversity we can obtain the necessary foods that we take pleasure in today. There have been and are today many threats to biodiversity. Habitat loss, pollution, overexplotion and consumption,etc… it takes more than 40 different species to make a simple lunch--a tuna sandwich on whole wheat, potato chips, iced tea and an apple. "Removal of one character in the play changes the entire scenery. The over-fishing of large predators like shark, leads to the natural balance of the seas being disturbed…"*

The next question prompted responses at the relational and extended-abstract stage:

> *Thought question: In your opinion why has the issue of mass extinction not yet resonated with the general public? Have you been concerned about the issue prior to this course?*

A response at the relational level demonstrates understanding of several components which are integrated conceptually (types of pollution, business concerns, protection of various species):

> R1: 1. *Unlike more visible environmental problems, such as air pollution and contaminated drinking water, the loss of obscure beetles and salamanders does not affect the daily lives of most people. 2. Furthermore, the business community is reluctant to support government regulations that restrict development to protect plants and creatures that seem to have little significance. That was dramatically illustrated in the late 1980s and early '90s, when loggers heatedly protested plans to set aside forests that were habitat to the rare northern spotted owl. So says William L. Kovacs, vice president of environmental and regulatory affairs for the U.S. Chamber of Commerce. "Let's prioritize what the real costs are, because our resources are limited. We can spend tens of billions of dollars in trying to protect something that has very little benefit to man." 3. Complicating the issue, scientists disagree about both the extent and the implication of mass extinction. In addition, some contend that concerns about extinction are overstated…*

At the extended-abstract level, understanding of several components which are integrated conceptually and can be applied to new situations (species protection, human health and mammal extinction) is demonstrated:

> *R2:…the public does not really understand the relevance of how one species can effect so much of the ecosystem. The lack of education is a big problem. The second reason is because it is not happening*

personally where the general public can really feel the effects right now. "One in eight known bird species around the world face a high risk of extinction in the near future, according to the authoritative 2000 International Union for Conservation of Nature and Natural Resources (IUCN) Red List of Threaten Species. That means entire species of birds face the same odds of disappearing from the planet for good as a woman in the U.S. does of developing breast cancer sometime in her lifetime. Mammals have it worse: One in four known mammals worldwide face a high risk of extinction in the near future."...

OVERVIEW OF FINDINGS

As the Tables at the back of this paper illustrate, overall the students in the sample reached higher order levels of thinking by week 3, after which pre-structural and unistructural levels of responses hardly play a role anymore. Although less sophisticated responses might be expected while the students were becoming familiar with the nature of the course and the tasks set, this is encouraging in that it at least confirms some kind of progression in the desired direction. Table 1 shows that 40% of the 193 student posts showed evidence of learning at a higher order level (R or E-A). Relational contributions made up 32% and extended abstract 8% in total. Table 2 indicates evidence of increasing levels of understanding in messages from week 1 to week 10. Posts at the unistructural level fall from initially 34% to 14.3 % of total posts. Multistructural posts show little movement overall whereas relational levels of learning increase from 18% to 40% and extended abstract from 0 to 8%.

Individual Student Movement

The majority of students in the sample benefited positively from the learning activities found in the Thought Conferences (see Tables 1-3). From this brief synthesis, overall it can be inferred that all students either maintained (student 1, 4, 7) or moved up (student 2 , 3, 5) in their levels of understanding within the first 10 out of 12 weeks. Although there may be any number of extrinsic or intrinsic factors at play in the difference between those who maintained their level of understanding throughout and those who progressed, the fact that some students did not progress as much as others perhaps illustrates a very important point about the design of learning tasks and activities. Despite the efforts of the tutor to present meaningful and engaging activities that are intended to challenge and benefit all their students equally (in this case, with the tutor purposively applying the principles of constructive alignment) some students will surely respond more ably than others.

Where students entered with an ability to engage at a higher level (student 6 and 8), this was maintained in the main for the relational stage but not so for the extended abstract stage of understanding. It is suggested that while it is unrealistic to expect students to operate at highest levels for every task at all times, there may be other factors that affected level of understanding in later weeks as well. This has already been explored in a study by Thomas (2002), in which students report that external pressures of increasing study load and examinations negatively impacted online conference participation rates. Dart and Clarke (1991) suggest that students faced with time constraints are likely to learn more strategically and to adopt surface approaches to studying to save time. This would apply to the sample of students in the case study who were increasingly faced with external pressures in addition to course-related, assessed tasks throughout the semester including written home assignments and a course paper. This is supported by the relatively high number of messages at the confirmatory level 'C' in weeks 6-10. In line with these findings, student participation in week 3 dropped by over 50%, most likely due to the first written home assignment that was to be submitted by the end of week 3.

The somewhat surprising decrease in SOLO level for those students entering the course with higher order thinking skills may be accounted for by the nature of the tasks, which for this group of students were perhaps not demanding enough. This is borne out of the fact that in direct response to requests by a small group of students a voluntary, long-term conference was opened in week 8 in which topics could be discussed in much more depth than in the weekly Thought Conferences. It was not uncommon for the quality of student engagement therein to surpass levels of understanding evident in the weekly Thought Conferences.

In week 8 high levels of cognitive engagement (Relational and E-A) were reached by more students than for any other week. It is suggested that revisions for the mid-term exam in week 7 prepared students particularly well for the following week's Thought Conference as these conferences always built upon knowledge constructed in previous weeks. In week 1 students engaged at predominantly lower levels of learning, which is not necessarily and indication of cognitive ability. The Thought Questions in weeks 1 and 2 were less challenging than in subsequent weeks, giving students time for online orientation activities and introductions.

Prior familiarity with online communication in the VLE seemed not to affect levels of learning online. Student online course experience ranged from none to 9 previous courses, and no link could be established between level of experience and level of understanding or rate of movement.

ISSUES IN APPLYING THE SOLO TAXONOMY

Overall, the SOLO taxonomy was straightforward to apply to direct responses to the Thought Questions the students tackled. However, coding the contributions the students made within the wider discussion, for example in response to or by picking up on what peers said, was more difficult. This is perhaps unsurprising given that the SOLO taxonomy is predominantly for evaluating individual responses to specific tasks. Interestingly, in order to categorise contributions to the wider group dialogue, two of the authors opted to analyse such responses by looking at the wider conversational context in which they were made, and in the independent first-pass analysis done so by creating 'contributes at unistructural/multistructural/relational/extended abstract' categories. This was done without knowledge of the other having adopted this approach.

Furthermore, on a related issue it sometimes proved difficult to distinguish between the level of learning achieved by the student author of a message, and mere expressions of confirmation, or repetition, of previous posts (by students or tutors). This was compounded by the fact that 10 different, albeit topic-related, questions were posted each week, and students might engage with a range of elements created in responses to a number of questions. Subsequently, agreement on the categorisation of some group dialogue posts was poor, and only after a collective closer analysis could an agreement be reached by the authors (one of which is a subject expert).

Finally, answers to fact-seeking questions for the purpose of collecting data could not be accounted for using SOLO, as the nature of the question limited the outcome to the repetition of figures. As indicated, this partly prompted the authors to expand the taxonomy to include a Confirmation level in order to account for them.

CONTEXTUAL FACTORS TO CONSIDER

A number of factors associated with the case study in question are felt to have affected the quality of student understanding, and the SOLO level reached, as demonstrated in the student messages. Prominent amongst these factors are the nature of the learning activity, and the role that was played by the tutor.

Regarding the nature of the ten Thought Questions posed each week, these prompted students to explore meaning, but on reflection did so to varying degrees. Three main types of questions can be identified, and are respectively argued to have played a role in the level of understanding that was realistically attainable.

The first type of question drew directly upon assigned readings, prompting students to focus upon the text and critically discuss it. The second type introduced a topic-related contentious current events issue providing links to references, and challenged the student to analyse a particular scenario informed by knowledge and understanding achieved in previous weeks. The third question type was a thought-provoking question related to a controversial issue, quote, or idea, and in response to which students were expected to take one position and deliver arguments in support of it informed by internal or external resources of their own choice.

Furthermore, half of the questions each week were either assigned to individual students as part of a poster/responder pair charged with beginning the discussion thread and the other half of the questions were open for discussion by all. The assigned questions were weighted more heavily than the non-assigned questions in the final assessment. Each related to the learning outcome(s) for that week. Students assigned to begin discussion threads generally demonstrated higher levels of thinking than in their responses to the non-assigned questions.

In relation to the tutor, tutor contributions made up 20-25% of the total posts. The visible presence of the tutor online, as well as her guiding and encouraging role throughout, is felt to have influenced students cognitive engagement with the material. In particular, students who did not evidence the expected level of understanding were prompted by a follow-up question to encourage further exploration (see Mainka et al 2005 for further elaboration). The implication, then, is that students may have posted a number of contributions at a higher level of the SOLO taxonomy than they may otherwise have, due to this assistance from the tutor (an assistance which is to be expected, but which some students thinking at a higher level may not necessarily have needed).

CONCLUSIONS

Overall, the SOLO taxonomy proved to be a reliable tool to straightforwardly apply to the majority of online discussion contributions within the course in question. It also provided some evidence of at least some students having moved to increasingly deeper levels of thinking in response to the online discussion activities they undertook, and proved suitable as a means for fairly accurately assessing the engagement of individuals in online discussion as demonstrated by the high level of inter-rater reliability following independent analysis.

However, the fact that the tool could not be applied without separately accounting for the confirmatory messages common within online discussion, and particularly the levels of thinking within contributions to a wider online debate rather than postings that directly address the original task or question, suggests that some

modification of the SOLO taxonomy along the lines indicated within this paper might be necessary for making it a more appropriate tool for analysing the levels of thinking apparent within online discussion contributions.

In relation to the constructively aligned activities undertaken, overall the evidence suggests that these effectively engaged the students in question. However some students certainly engaged more effectively than others, and for those who did so at the higher levels from the outset, there may be doubts around whether the questions set proved challenging enough. For those who did not seem to progress to the higher levels of thinking over the time of the course, or who needed the intervention of the tutor to push them further, it may be that the analysis presented simply confirms that it is the individual student that ultimately determines how well they learn.

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TABLES

WEEK:	**1**	**3**	**6**	**8**	**10**
PRESTRUCTURAL	2%	0	2%	0	0
UNISTRUCTURAL	34%	4.8%	10.2%	5.3%	14.3%
MULTISTRUCTURAL	20%	33%	32.6%	18.4%	22.9%
RELATIONAL	18%	33%	32.6%	39.5%	40%
EXTENDED ABSTRACT	0	19%	4.1%	15.8%	8.6%
[R PLUS E-A]	18%	52%	36.7%	55.3%	48.6%
CONFIRMATORY	26%	9.5%	18.4%	21%	14%

Table 1: SOLO level reached by % each week

	WK 1	**WK 3**	**WK 6**	**WK 8**	**WK 10**
STUDENT1	0	0	42.9%	0	0
STUDENT2	7.7%	33.3%	36.4%	44.4%	50.0%
STUDENT3	33.3%	0	25.0%	40.0%	60.0%
STUDENT4	0	0	0	50.0%	0
STUDENT5	37.5%	75.0%	100%	33.3%	50%
STUDENT6	50.0%	50.0%	50.0%	75.0%	20%
STUDENT7	0	0	0	0	0
STUDENT8	42.9%	0	50.0%	50.0%	42.9%
STUDENT9	12.5%	33.3%	0	100%	0

Table 2: Relational level in messages as % of individual postings per week

	WK1	WK3	WK6	WK8	WK10
STUDENT1	0	0	0	0	0
STUDENT2	0	16.6%	0	33.3%	10.0%
STUDENT3	0	0	0	0	0
STUDENT4	0	0	0	0	0
STUDENT5	0	25.5%	0	16.7%	0
STUDENT6	0	50%	50%	33.3%	20%
STUDENT7	0	0	0	0	0
STUDENT8	0	33.3%	0	16.7%	14.3%
STUDENT9	0	0	0	0	0

Table 3: Extended abstract level in messages as a % of total individual postings per week