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Bi-Directional Symbiotic Learning Model for Domain Knowledge Sharing

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Abstract: The advent of Information Technology has led to increased access to domain knowledge, thus breaking the barriers to knowledge sharing and in turn, greatly benefiting both the teaching and learning community. The current IT-Driven proliferation of knowledge implies that teachers can neither be viewed as sole custodian of knowledge, nor the students as those who know very little. The teaching community must strive to be abreast with the current realities; else, the teachers' knowledge may become obsolete compared to those of the learners. This research proposes a Bi-Directional Learning Model rooted on collaborative academic growth through effective knowledge sharing. This study begins with an unambiguous clarification of the subject matter using two symbiotic animals as cited in a popular scientific research. The bi-directional model building blocks as well as an expanded framework were designed from the scratch and explained. The concept of symbiotic benefits in bi-directional learning was illustrated using a special data structure called the symbiotic benefit matrix. The computational technique of divide and conquer through formal proof was applied on the bi-directional model workflow vis-à-vis the symbiotic benefit matrix, thus reducing the research problem to the barest minimum. The final outcomes of this work emanate from a research survey specially designed to elicit first hand experiences on the subject matter from respondents, who were mainly seasoned professors, drawn from 32 Universities through a research cluster. A major finding is that bi-directional learning could be of immense benefits to the academic and scientific community, though it could be impeded by a number of factors, some of which were also identified.

Key words: Syben Matrix · Evolutionary Workflow · Benefit Matrix · Information Technology

INTRODUCTION

The Cambridge Dictionary Online [1] defined symbiosis as a relationship between two types of living things in which each provides for the other the conditions necessary for its continued existence. It is further defined as a relationship between people or organizations that depend on each other equally. The concept of symbiotic learning in academics has been pointed out by researchers, though more active research is still expected in that regard. A recent study [2] established that progressive institutions of learning strive to maintain a symbiotic collaboration between the school and the parents of the students. According to the researchers, there is strong evidence that such a relationship leads to improved students' performance as well as the growth of the institution itself. This assertion was further substantiated by listing previous works such as Henderson and Berla [3] and Jeynes [4] which made similar findings.

A scientific research [5] to investigate how teachers can improve their practice made reference to symbiotic learning. The author believes that every student within the classroom has the capacity to develop the techniques of critical thinking [6], coupled with the skills of independent enquiry. It was further stressed that by helping the student to develop academically, there is corresponding increase in the probability that the teacher could learn from the student in the future. The research asserted that the teacher should neither assume

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Fig. 1: The Crocodile and the Plover [7]

the position of a sole custodian of knowledge, nor view the students as shallow minds with little or nothing to contribute. Bi-Directional Symbiotic Learning Model is purely a knowledge sharing concept, whose definition has nothing to do with the giving or receiving of material gratifications in order to win the favor of the opponent.

Research Motivation: The motivation for deeper studies on symbiotic learning model was triggered by Fig. 1 captured from a scientific research [7]. The figure shows a crocodile and a plover – a fearless bird. Both animals are comparable to the symbiotic entities, such as teacher and student respectively as focused in this current research.

The crocodile is obviously stronger than the plover but, instead of harming the bird, the crocodile protects it. The reason is because the plover benefits the crocodile by feeding on the parasites scattered in the mouth of the latter. In a similar way, "Could the teacher learn from the students in the process of teaching?", "If so, how can this be achieved?" These are some of the important questions that motivate this work.

Model Evolution Steps

The Building Blocks: The four evolutionary symbols or building blocks used for model construction are shown in Fig. 2, Fig. 3, Fig. 4 and Fig. 5 respectively. The first is the symbiotic entity SE. Symbiotic entities are the key players in the symbiotic relationship. This work considered the two symbiotic entities {SE1, SE2} = {T, S} where T = 'Teacher" and S = 'Student'. A cuboid is used to designate a symbiotic entity in a model diagram [8].

The next symbols are the bi-directional arrows [9], used to indicate the direction of the model flow. The left and right (bi-directional) arrows are shown in Fig. 3.

The third building block is known as the symbiotic action, designated with a pentagon [10]. It represents the actions taken by the symbiotic entities. It is shown in Fig. 4.

Every symbiotic relationship leads to a benefit accruing from the opposite entity. Thus, the spherical symbol [11] is used to indicate the symbiotic benefit.

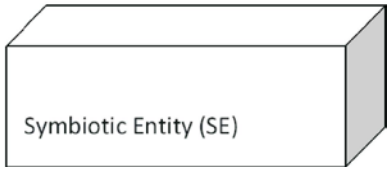

Fig. 2: First Evolutionary Symbol (Symbiotic Entity SE)

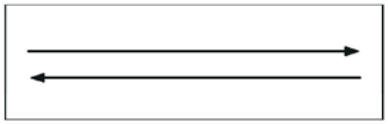

Fig. 3: Second Evolutionary Symbol (Bi-Directional Arrows)

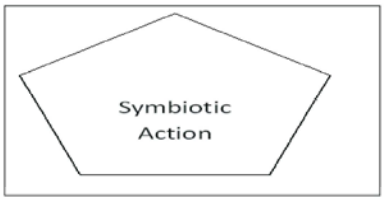

Fig. 4: Third Evolutionary Symbol (Symbiotic Action)

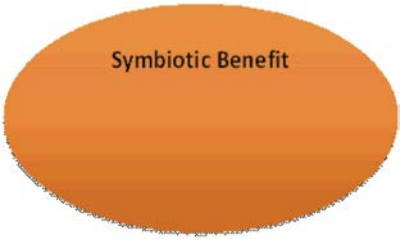

Fig. 5: Fourth Evolutionary Symbol (Symbiotic Benefit)

The Simplistic Workflow Diagram: Based on the earlier definitions, any two entities involved in a symbiotic relationship usually take complementary actions to benefit the opponent. This is the origin of the word 'bi-directional' as used in the model nomenclature [12]. Thus, at the fundamental level, a typical symbiotic relationship can be reduced into a simplistic workflow [13] diagram in Fig. 6, consisting of just two symbiotic entities and the bi-directional arrows.

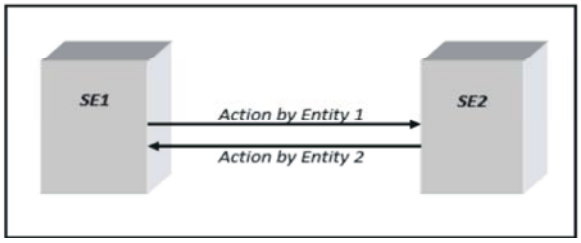

Fig. 6: Simplistic Workflow Diagram

Symbiotic Actions and Benefits Codification: Apart from the building blocks, a number of codes or acronyms were developed to represent important information in this work. As earlier stated, the symbiotic entities - 'Student' and 'Teacher' are represented using the codes S and T respectively. The actions taken by each of the entities are likewise codified as follows: AT stands for "Action by Teacher" and AS stands for "Action by Student" respectively. Since symbiotic actions give rise to symbiotic benefits, special codes have also been formed for benefits as follows: BS stands for "Benefit Student" and BT stands for "Benefit Teacher" respectively.

Based on the law of combinatorics [14], four possible categories of benefits could be derived by cross-linking actions and benefits in symbiotic learning. These are codified as BSAT, BSAS, BTAT and BTAS respectively, as explained in a symbiotic benefit (SYBEN) matrix. The SYBEN Matrix is a special 4 by 3 structure that shows the details of the bi-directional learning benefits categorization, semantics and extended comments as shown in Table 1.

Table 1: The Symbiotic Benefit (SYBEN) Matrix

Benefits	Interpretation	Comments
BSAS	Action of Student; Benefits Student	Given/Simplistic
BSAT	Action of Teacher; Benefits Student	Given/PPV
BTAT	Action of Teacher; Benefits Teacher	Given/Simplistic
BTAS	Action of Student; Benefits Teacher	**Research**

The first column of the SYBEN Matrix lists the four benefit categorization codes [15] earlier mentioned. Each of the codes is made of four letters. The code semantics [16] or interpretation follows a special letter ordering 3rd, 4th, 1st, 2nd respectively, where the 4th and 1st are separated by a semi colon. For instance, since the letter 'A' stands for 'Action', 'B' for 'Benefit', 'S' for 'Student' and 'T' for 'Teacher', the benefit code BSAT is interpreted as 'Action of Teacher; Benefit Student'. In other words, BSAT represents academic advancement benefits accruing to the student, as a result of the actions of the teacher (teaching in the class room).

Detailed Workflow Diagram: A detailed workflow resulting from the codification [17] steps vis-à-vis the SYBEN matrix is shown in Fig. 7.

As shown in the diagram, arrows leaving the symbiotic entities are direct actions AT and AS, taken by teachers and students respectively.

On the other hands, the post-action arrows give rise to the four benefit codes BSAT, BSAS, BTAT and BSAS respectively. Finally, the post-benefit arrows point towards the entities that enjoy such benefits.

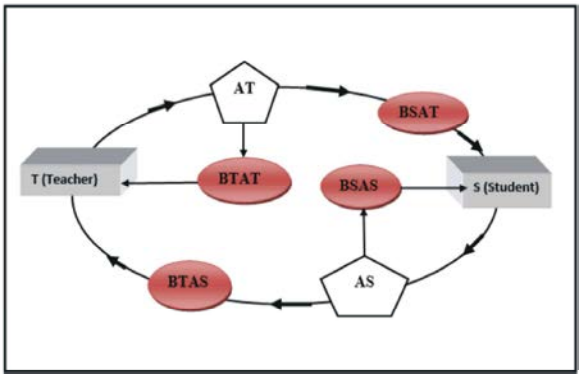

Fig. 7: The Bi-Directional Symbiotic Learning Model Flow Diagram

Divide and Conquer Solution Step: The computational technique of divide and conquer [18] was applied on the bi-directional model workflow in Fig. 7 based on the contents of the SYBEN matrix. The intention was to use formal proofs [19] and modular solutions [20] to reduce the research problem to the barest minimum, after which a survey research was applied on the remnant. This is explained as follows. A major focus of this research is to model bi-directional knowledge transfer benefits arising between the symbiotic entities – Student (S) and Teacher (T) in an academic learning environment.

In the 'Comment' column of the SYBEN matrix [21] in Table 1, the benefit codes 'BSAS' and 'BTAT' were categorized as 'Given/Simplistic'. This is because, it is natural for someone to take actions that would be of benefit to himself (or herself) as the case may be. In other words, from the academic point of view, it is very easy to deduce that the possibility of bi-directional actions/benefits for these two is surely simplistic. Thus, further research on BSAS and BTAT is not necessary.

The new structure after weeding off [22] the two simplistic benefits codes is the optimized version of the symbiotic model diagram in Fig. 8. As shown in Fig. 8, the remaining symbiotic benefit codes are BSAT and BTAS. Again, from the comment column of the SYBEN Matrix, BSAT is categorized as 'Given/PPV'. The acronym 'PPV' stands for 'professional point of view'. It is clear from the professional point of view [23] that a teacher naturally teaches so that the students may benefit from his or her teaching. On the contrary, it would be abnormal for any teacher to teach with an intention that students should not learn.

Thus, the third benefit code BSAT is also simplistic leaving only BTAS for further research. In other words, the Bi-Directional Model can be stated simply as follows:

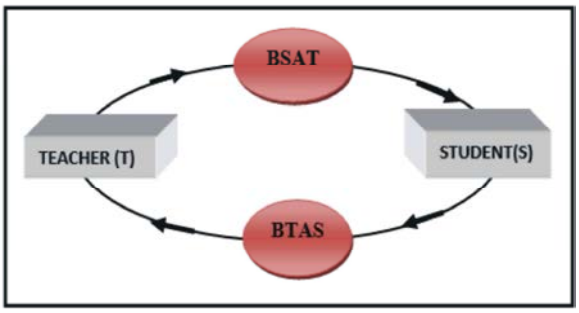

Fig. 8: The Optimized Version of the Bi-Directional Learning Model

BTAS → Action of Students Benefit Teachers

This will be the focus of the remaining part of this work which is based on a research survey.

Research Dataset and Analysis: This study on bi-directional symbiotic learning was first initiated in 2014. Data on symbiotic learning experiences were captured from seasoned professors and lecturers through the platform of the Nigerian Research and Education Network (NgREN). The NgREN is an inter-university nation-wide collaborative research cluster [24]. The core objective of NgREN is to provide both local and international interconnectivity to enable researchers to create and share requisite academic contents, develop high impact collaborative teaching and learning platforms, develop high impact collaborative research programmes and develop advanced science and technology talents. Data collection was initiated during the NgREN workshop held in Port Harcourt in May 6, 2014 and later on September 23, 2014 in Abuja both of which the researcher was in attendance.

A total of 32 universities, whose websites are enumerated in Table 2 were represented in the two workshops. Each university nominated at least four representatives, giving rise to a total of over 100 respondents, out of which about 50% were seasoned professors, while the rest were in the categories of university lecturers of lower cadres, researchers and directors of ICTs in their various institutions. The contact information of the respondents was harvested from the workshop attendance list, through which the questionnaires were administered through e-mails. Data extraction [25] from respondents was complemented through direct interviews and phone calls to the respondents, all of which were completed within about 12 months. The data extraction instrument was carefully designed to be as unambiguous as possible. It consisted of 23 questions, with the first three geared at ensuring that the respondents were experienced enough to participate in the survey, while the remaining questions were core to the subject matter of the research. The extracted data were consolidated and analyzed, giving rise to a number of research findings.

Table 2: Institutional Sources of Dataset (32 Universities)

S/N	University	S/N	University
1	aabu.edu.ng	17	fuoye.edu.ng
2	ansu.edu.ng	18	fupre.edu.ng
3	atbu.edu.ng	19	futa.edu.ng
4	buk.edu.ng	20	futminna.edu.ng
5	ebsu.edu.net	21	futo.edu.ng
6	funaab.edu.n	22	lautech.edu.ng
7	funai.edu.ng	23	mouau.edu.ng
8	fuotaoke.edu	24	nda.edu.ng
9	oauife.edu.n	25	unilag.edu.ng
10	pau.edu.ng	26	unilorin.edu.ng
11	run.edu.ng	27	unimaid.edu.ng
12	udusok.edu.ng	28	uniport.edu.ng
13	ui.edu.ng	29	uniuyo.edu.ng
14	umyu.edu.ng	30	unizik.edu.ng
15	uniben.edu	31	ust.edu.ng
16	unijos.edu.ng	32	ndu.edu.ng

Summary and Findings: The outcome of this study on bi-directional symbiotic learning as outlined here represents an overwhelming view of over 90% of the respondents.

One of the findings of this research is that, though it is natural for students to learn from teachers, intelligent and experienced teachers are aware that by teaching, they are indirectly learning and sharing knowledge with the students. It was however discovered that though many respondents agree that teachers could benefit from the knowledge of the student, a large percentage (over 50%) do not subscribe to making the students realize that teachers benefit from students' knowledge. This is probably to protect the teachers' egos.

Secondly, this research unraveled a number of strategies that encourage bi-directional symbiotic learning. Three of the most favored strategies are: Brainstorming Sessions [26], Goal-Oriented Discussions [27] and Case-Based Teaching and Testing [28]. It is recommended that the teacher should initiate the discussions and allow the students to make inputs. The result of this research also points to two major behavioral tendencies that could inhibit symbiotic learning. These are pride and constant intimidation emanating from the teachers and directed towards the learners.

This work also showed that while searching for fresh information [29] or ideas, contemporary learners resort to the Internet, much more than they use either library books (hardcopies) or teachers lecture notes. The implication is that since both the learning and teaching communities have access to online information, the possibility that the students could make new discoveries and share same with their teachers is very high. This goes a long way to substantiate the fact that teachers could indeed learn from the students, though indirectly.

In summary, this work has showed the importance of bi-directional symbiotic learning. The model building blocks as well as the workflows [30] have been designed from the scratch. This work has also demonstrated the use of algorithmic techniques to reduce the problem size and then applied survey research in order to derive some outcomes that support bi-directional symbiotic learning concept. This study is a work-in-progress, which no doubt, requires future extensions. Thus, future studies intend to focus on how to apply artificial intelligence in bi-directional symbiotic learning.

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