Education 2.0: Student Generated Learning Materials through Collaborative Work

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Abstract

The Inside-Outside strategy pushes students to be more involved in their learning. As shown by the Integrated Learning Processes model this improves learning. A course on operating systems was redesigned in such a way that students would generate most of their learning materials as well a significant part of their evaluation exams. This new approach resulted in a statistical significant improvement of student's grade as measured by a standardized exam compared with a previous student intake.

Keywords: Collaborative learning, Integrated Learning Processes, Natural Learning, Google Drive

1. Introduction

In today's work environment, more than just technical skills are required from professionals. Skills such as teamwork, decision making, conflict resolution and other similar skills are just as important as design, management and diagnostic skills. Those skills are not easily acquired in today's learning environments as certain prerequisites need to be present such a structured approach, communication facilities, training of teachers and students. Simple teamwork assignments will often not teach such skills, more complicated scaffolding needs to be present in learning environments that will ensure collaborative work will help students acquire those skills and ensure correct transfer to work environments.

Also, it's a well-known fact, that the more engaged a student is to her learning, the better learning is achieved. Engagement is directly linked to motivation. As we will discuss later in this article, motivation improves learning, as well as convincing students that learning is about real life, that they are stakeholders on their own learning.

The Integrated Learning Processes (ILP) [1] model is a four stage learning model that conforms to Kolb's natural learning cycle. ILP consists of four distinct stages in which different parts of the brain are activated and used, as described by James Zull [2] [3], in order to improve learning. In order to achieve real, long-lasting learning, the learning cycle must be completed.
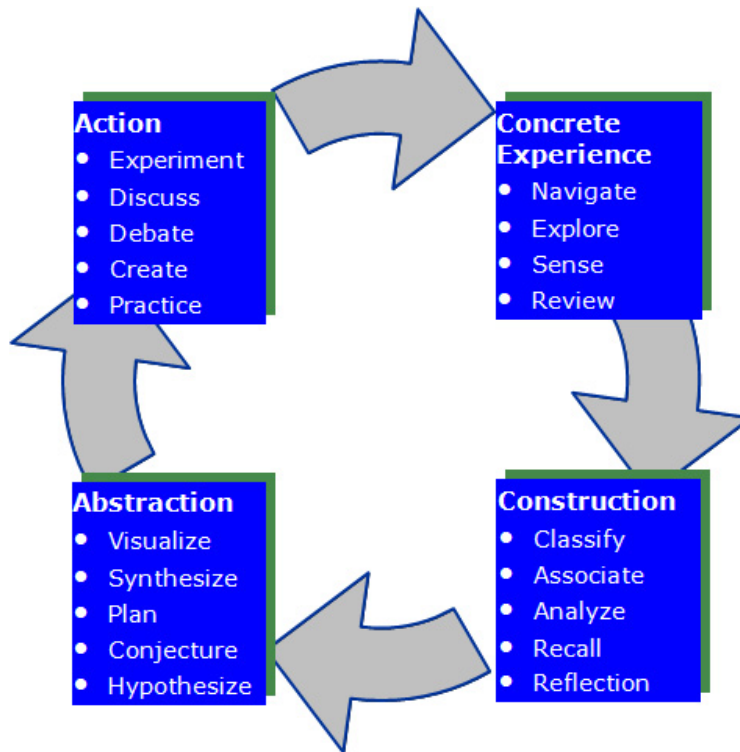

Figure 1. Integrated Learning Processes Educational Model [1]

To allow students to acquire soft skills like the ones we have mentioned and to improve learning on computing and engineering students, we present a new learning strategy called Inside-Outside (I-O). In this learning strategy, students work collaboratively to develop their own learning materials. Students develop memorization questionnaires, discussion topics and questions, schemas and synoptic tables, relation trees and other visualization aids. They also develop specific problems and exercises that are included in their exam evaluations. This learning strategy has been statistically proven effective in improving learning in students by increasing their engagement, motivation and interaction between themselves. It seems also that the strategy improves student's skills at coordinating tasks, making decisions and solving conflicts. We call this Education 2.0 as an analogy between Web 1.0 and Web 2.0. Just like in Web 2.0, in Education 2.0 students create their own learning material and have freedom as to how to use them to improve their learning.

In the first section of this article we will review the ILP model and will explains how it relates to the I-O strategy. In the next section, we will explain the elements that constitute collaborative learning and how those elements are present in the new strategy. Next, we describe the I-O strategy itself and present the results obtained by using it in undergraduate students. Finally we draw our conclusions.

2. The Integrated Learning Processes Model

The Integrated Learning Processes (ILP) model is based on three principles:

- Kolb's [2] learning cycle, which James Zull [3] links to specific parts of the brain and establishes as essential for learning as shown in Fig. 1. The ILP model is the based on the repetition of four stages of learning that activate different areas of the brain as discussed in [1]. Any new learning strategy must establish how it goes through the learning cycle. Table 1 shows this for I-O learning strategy.

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ILP Stage	I-O Stage
Concrete Experience	Hear problem statements and background information View videos and objects Read documents Feel objects
Construction	Discuss how the new information relates to life Create analogies, similes, metaphors Recall anecdotes and stories Classify and find relations between concepts Analyze, identify functional parts
Abstraction	Create a hypothesis Visualize through flow charts, relational charts, comparison tables, synoptic tables Create a synthesis
Action	Create questionnaires and exercises Discuss the solution to each question Practice solving exercises

Table 1. Relation between the Integrated Learning Processes model and the I-O strategy

- A progression of increasing knowledge complexity that follows the path: Conceptual and Contextual Knowledge->Procedural and Problem Solving Knowledge->Cognitive complexity knowledge. In our case, Table 2 shows this for the I-O learning strategy

Knowledge Level	I-O Level
Conceptual and Contextual	Students create and discuss the solution of questionnaires based on memorization Students design questions to engage in discussions
Procedural and Problem Solving	Students design exercises and problems Students learn to create those questions working together and how to discuss the solutions
Cognitive Complexity	Students not just answer questions, they make them. The questions have to be unique and with appropriate complexity or difficulty. Questions will be evaluated by peers, and since they might also be included in exams, all participants are stakeholders for all questions

Table 2. Taxonomy of items to be included in questionnaires

- The use of social interaction and the presence clear and present motivators. Motivation is based on the following elements:

a) An orthodox use of collaborative learning
b) The presence of Active Learning
c) Putting the students at risk
d) Showing that learning is about improving life.

We believe that the I-O strategy increases motivation by including in its methodology these elements in the following manner (see Table 3):

Motivation Element	Implementation in I-O strategy
Collaborative Learning	The I-O is constructed around a scaffolding of collaborative learning as described in section 3. Although collaborative learning does help students acquire many skills, the relevant point here is the social interaction carried out. As pointed in [4], social interaction is critical to motivate students. Also, competition between teams is carried out implicitly, when the work of a particular team is recognized and rewarded. This reward is realized by using a team's problems in the written exam. Therefore, the team that made the problems has an advantage over other teams
Active Learning	As discussed in [4], active learning is germane to motivation. Action brings pleasure. And achievement brings pleasure. But also by including student developed questions in exams, student work gets recognized, improving motivation
Putting Students at Risk	As discussed in [1] we use Vygotsky's zone of proximal development and educational scaffolds [5]. This is what we mean when we say "put the student at risk". We present students with problems in which they have a probability of failure [6], so they may develop ever more complex thinking strategies. Also, scaffolding is also used when students do on-the classroom activities which consist on solving problems of ever increasing difficulty and having the teacher assist only as a mentor.
Showing that Learning is About Improving Life	As we discussed in [1], learning is an evolutionary tool and as such, its main objective is help humans survive. Therefore, learning becomes more significant when learning is related to student's background, interests, daily activities and society. This is attacked in two fronts: 1) Similes, analogies and metaphors are used so students can identify with the contents, even if they are highly analytical 2) When students understand that their work can mean a real advantage on the evaluation process, the tend to improve their efforts in order to have questions developed by them included in the exam

Table 3. Social interaction and motivators for de I-O learning strategy

3. Collaborative Learning

A common definition of Collaborative Learning (CL) is: "involved joint intellectual effort by students or students and teachers. Groups of students work together in searching for understanding, meaning, solutions or in creating a product" [7].

One of the most important principles in collaborative learning is "Positive Interdependence". Positive interdependence is "the degrees to which participants perceive they are interdependent in that

they share a mutual fate and that their success is mutually caused" [8]. Although there are other important aspects of collaborative learning, positive interdependence stands out because is not only encourages knowledge and skills acquisition, but it also encourages the practice of certain attitudes and values such as respect, responsibility to others, personal accountability, self-evaluation, etc. [9] [10].

Elements of Collaborative Learning

There are five elements of collaborative learning [8]:

1. **Clearly Perceived Positive Interdependence**. In collaborative learning the success of one person is bound up with the success of others. There are many ways to ensure positive interdependence. Goal sharing is one way. This might include shared subject matter, a particular assessment, joint problem solving or creating and discovering something of value. Another way is role sharing. This occurs when each group member is given a specific role that gives a person specific responsibilities. The role describes what group activities that person might take and the contribution to the overall task. Also, resource information contributes to positive interdependence and exists when each group member has only part of the information, cases, material or other resources necessary for the group to achieve its task. Finally, task interdependence is structured by creating a division of labor so that the actions of one group member have to be completed before the next member can complete their tasks.
2. **Interaction**. Individual students are encouraged to assist others in the group to complete tasks in order to reach the group's goals. In other words there is an expectation that students will help each other so that common goals can be achieved. Help may be resources, advice, provision of feedback and challenging conclusions.
3. **Individual Accountability and Personal Responsibility**. Everyone is expected to do their fair share of work and it is important for all group members to know that they cannot 'free ride.'
4. **Small Group Skills**. Interpersonal skills such as making decisions and solving conflics are important. In order to achieve these goals students must:
    i)   Get to know and trust each other
    ii) Communicate clearly
    iii) Provide and accept support
    iv) Resolve conflict constructively
5. **Group Processing**. Group work is effective when group participants reflect on how well they function as a group. This reflection assists members to maintain good working relationships. Reflection may focus on such things as relationships between people, facilitation of collaborative skills, rewarding of positive behavior and the celebration of success.

The correct use of CL is very important to the I-O strategy. Since I-O relies so much in teamwork and collaboration, a failure in this part will cause students to simply divide the work among themselves and then getting later together to simply ensemble the whole. This will in turn cause students to learn only a part of the intended learning objective, creating less efficient learning, not better learning. Students will do worst in exam than in a regular course. Positive interdependence must be created in order to have all students learn all the material.

4. The Inside-Outside Learning Strategy

As stated in [1], any balanced approach is based on three transformations of knowledge and one transformation of emotions that must take place in order to achieve deep understanding and competence:

1. **From past to future**. Information given to students is by nature the past. Students must be able to make plans and create strategies: that is to project past learning into the future. This is effectively achieved when we transition from reflective observation to abstract hypothesis. Observations are in the past, therefore we reflect about those observations. Plans and hypothesis intend to predict the future.
2. **From inside to outside**. Human beings receive knowledge through their senses. It must then be effectively stored. After such process, new knowledge is created, transforming students from knowledge receivers to knowledge producers. Again, this is achieved in the transition from reflective observation to abstract hypothesis. We store inside our minds, in our memory, knowledge that we took from the outside. When we make plans or create hypothesis, we project what we know and create new knowledge about the real world, the world outside our mind. This the transformation of knowledge that gives the strategy its name.
3. **From learning to teaching**. This is a power transformation in which initially students are dependant on outside authority to inform them. Eventually, students take control of their learning taking decisions of how, where and why. Teachers become tutors and even mentors, through a carefully constructed scaffolding lattice of slowly retracting learning support, until student become experts on the knowledge area.
4. **Motivation**. Students will be presented with knowledge that is meaningful, that relates to their needs, their work responsibilities, they environment, their culture, and their background. This will motivate students to be involved and active participants of their learning, as it is interesting to them, and most of all, useful. Another source of motivation is sensation of movement through active learning and the sensation of achievement, through evaluation and feedback.

The Inside-Outside learning strategy intends to emphasize the transformations: from inside to outside and from learning to teaching.

In the I-O learning strategy, students collaborate to create their own learning materials. Students develop memorization questionnaires, discussion topics and questions, schemas and synoptic tables, relation trees and other visualization aids. They also develop specific problems and exercises that are included in their exam evaluations. Each learning item developed by students is peer-reviewed before being approved as a learning material.

The general algorithm is as follows:

*   Students are organized in three-member teams. Two-member teams are accepted, but discouraged. Students working alone are not accepted (as one of the objectives is to develop the capacity for social interaction), and also teams with more than three members are not accepted to avoid free rides
*   Students are asked to take any of the three roles: coordinator, speaker and information specialist.
*   A coordinator is someone with high degree of management activities. She is not the boss, but she will coordinate the work of the team

- A speaker is someone that is able to speak in public and defend the team's perspective
- An information specialist is someone who knows where knowledge is stored or can be acquired.
- Students are asked to read all the material related to the particular educational objective at hand. Students may need to answer a quiz in order to ensure that they have reviewed all the material. At this moment the teacher can resolve questions and concerns. A fraction of the learning objective is handed to each team. Each team is to create original questions and other learning materials from the part of the learning objective assigned to it. At this moment, more question and concerns come out and the teacher resolves them
- Students use **Google Docs** or **Google Drive** to transparently write their learning materials. Learning items are classified as Memorization, Discussion and Problems Solving. Each team is required to create at least one question of each type of item.
- Students work in the classroom to create the items. Teacher clears any questions or concerns right before the start of the design of the learning materials and also during the development of the original questionnaire since more questions and concerns will arise as students struggle to design learning materials. In this respect, the teacher acts as much as a mentor as a teacher.
- Review collectively. All new items of the questionnaires must be reviewed by all students to ensure that everybody understands what is exactly that is expected as an answer and that all necessary data is given in every item.
- Then, the teacher must include exercises and discussion question that she feels that need to be answered additionally to those designed by the students.
- In order to be thoroughly prepared, all students must be able to answer all questions and exercises. Students do work both in the classroom and at home. Naturally it's better to do as much work in the classroom as possible, having the teacher as consultant and guide. But a lot of work will also be done at home, so students must learn to coordinate geographically separated entities.
- Each team publishes the answer to its questions. It is very important at this point, that all the discussions designed by students be carried out, as they help link new knowledge to previous knowledge. The correctness of the answer of each problem and exercise must be assessed, as this will end any remaining misconceptions, erroneous mental associations or down right mistakes in student's calculations. Therefore, the transformation from reflective observation to abstract hypothesis must be also asserted.
- The learning material is ready to be used by future generations. And the group is ready for qualitative exam assertion. Furthermore, if a non-negligible part of this exam is constructed by using student generated questions this create a positive cycle in which items in the questionnaire will be increasing in quality as the course progresses. Also, if the criteria to select the questions is very clear, this creates healthy competition between teams as each team will strive to get as many owned questions as possible in the exam. Also, teams that do not get their questions included in the exam will improve if only to avoid low self-esteem.

5. Results and Statistical Analysis

The results of the I-O learning strategy were compared using standardized tests between two cohorts of students. The chosen class was Operating Systems. The first cohort Jan-11 consisted of 28 students. That course ran from January to May 2011. The second cohort Jan-13 consisted of 15 students and it ran from January to May 2013. The academic objectives were identical and the exams were nearly identical. In total, four exams were carried out, three partial evaluations and one final assessment. We will present the results of only one test, which is the one in which I-O was used exclusively as learning strategy, whereas in the other evaluations, although with results consistent with the one we are about to present, used mixed learning strategies.

We present the results on the second partial evaluation. The Jan-11 cohort used a learning strategy in which students answered and discussed among themselves as teams and with the teacher a questionnaire designed by the teacher which contained memorization items, one or two discussion items and finally, problems to be solved. The Jan-13 cohort used for the second partial evaluation a strategy that was on the mechanics, similar to the Jan-11 strategy. Students will answer and discussed a questionnaire consisting in memorization questions, discussion questions and exercises. The main difference was that for the Jan-13 cohort, the questionnaire was collaboratively designed by the students, not the teacher. In the associated exams, in which the scores are graded from 0, all answers wrong, to 100, all answers correct, were as follows (see Table 4):

	Jan-11	Jan-13
Count	28	15
Mean	71.43	78.40
Variance	172.99	151.69
Std Dev	13.15	12.32

Table 4. Statistical results of assertion exam

As can be observed in Table 4, cohort Jan-13 did better in average grade and variance. A test was carried out to verify that the difference in the mean grade observed was statistically significant [11]. The hypothesis tested was that there is no statistical difference in the means, and therefore the means are statistically equivalent. From tables we observed that t critical was to be 1.682878. As the computed t was -5.28953 and since t critical is greater than t computed, we reject the hypothesis and thus, the means are statistically different. This means that the mean from the Jan-13 cohort is greater the mean from Jan-11 cohort. This is evidence that the I-O strategy improved learning.

6. Conclusion

Collaborative Learning has many advantages over traditional learning. Mainly, it gives support to students by creating positive interactions between students, creating shared experiences that derive in comradeship within teams and most importantly, motivating students. The Integrated Learning

Processes model allows the construction of a learning process that drives students to achieve natural learning by creating scaffolding according to Vygotsky's [12] in which students acquire ever increasing independence and deeper understanding on the knowledge and skills they will need to perform in society. This is achieved by creating learning experiences in which different parts of the brain that are involved in learning are addressed in a carefully constructed sequence of events.

The Inside-Outside learning strategy helps students not only to learn new concepts and procedures, but also to transform knowledge in a way that follows the Integrated Learning Processes model and facilitates the complicated jump from analysis to synthesis and from reification to planning. As a side effect, it diminishes the chances of plagiarism since at every cohort of the course student produced learning activities will be different from each other. This may be one of the key factors in improving learning.

7.   Bibliography

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