

Combining Independence and Cooperation as One Anarchic-Style Learning Method

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Abstract—The engineering education is facing a demand for a change in the current teaching approach that would satisfy the needs of employers and face the constantly changing professional requirements. The current paper aims to analyze two common teaching approaches that are frequently used among learning academics, the collaborative and the independent teaching approaches and compare the results with other learning techniques that were addressed in previous academic years of teaching the Software Project Management course at the "Politehnica" University of Bucharest for students in their senior year of studying Computer Science and Engineering. Considering the results gathered from the experience with the two aforementioned approaches, we developed a "mixed" learning method, combining elements from both forenamed learning techniques as one anarchic-style teaching method, which is also described.

Keywords—Educational models, independent learning approach, software project management, teaching strategies.

I. INTRODUCTION

LEARNING can be seen as a process characterized by a set of pedagogic relations that incorporates a relationship between a learner and a stimulus that would lead to an internal change for the learner which eventually will be exteriorized as a performance. From another point of view, learning is a two-way street with instructors and students being two essential components of the educational system. In this context, it comes across as imperative for learning techniques to offer students opportunities in order to maximize not only their professional potential, but also their personal skills. Thus, taking into consideration the background of an increasingly globalized business oriented environment, the question whether a certain learning approach is preferable to others in the process of enhancing professional and personal development of students is of utmost both theoretical and practical importance.

Current research in the field is aimed at developing a more student-centered approach to teaching, rather than improving on the traditional approach, where the teacher presents the

subject to the more or less attentive students. Collaborative learning among students can achieve this goal.

Through collaborative learning, groups of students work together to achieve a task offered by a coordinator or teacher. Learning in small groups has been practiced by many professionals since the 1970s, with the purpose of producing better academically-oriented students.

As a pedagogical tool, human interaction always enhances learning. Students are able to learn at a deeper level when working together because they have to interact with others, understand one other while being exposed to a variety of thoughts, perspectives and thinking styles. Finally, interacting with others and working in multiple clusters increases motivation, a crucial element in learning. Human interaction can also help students become better human beings, this being the fundamental purpose of education.

However, independent learning, or the traditional method of teaching, has its important role, especially for building the foundation. Working in groups can give a false impression of immediate understanding; these gaps, if at the basis of the taught subject, can later prove to be hard to fill. Thus some time alone for digesting the material is essential.

According to a study published by UNESCO, engineering education has developed learning difficulties at the organization level, as well as at the student level [31], therefore there is a need for changing the current teaching and learning approach, in order to ensure that engineering graduates can apply the practical and theoretical knowledge acquired during university years for solving problems, by putting into practice their theoretical understanding, creativity, team-working and business skills [32].

The following chapters touch upon about each method individually, then we refer to our tests during the Software Project Management (SPM) subject and offer a solution for combining the two approaches into an approach that retains the positive aspects from each, along with results from our class. A similar approach has been described by Boiangiu, Firculescu, Cretu and Zugravu [35] in a study regarding teaching techniques in academic learning environments.

II. OVERVIEW OF THE APPROACHES

A. Independent approach

This method is still the preferred method of teaching in undergraduate environments, because it still manages to satisfy

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the pupils' requirements very well. The needs of the young age children, from the scholar point of view, are limited to learning concepts with which they will operate in the future. These concepts are generally offered by an instructor, who also has the role of periodically monitoring each pupil for the grade of understanding.

For project-based university assignments, the "independent projects" teaching strategy creates small groups of students working on totally different projects. They compete in order to sell and advertise to the sponsor the most appealing product. In this situation, the complexity of the project might not matter in the eyes of a possible buyer, thus making it a challenge not only from a technical perspective, but also from a marketing perspective. Following this strategy, students might find it easier to choose and apply to a more preferable project, thus allowing for creativity and a high level of enthusiasm.

Compared to the other teaching strategies, the independent project teaching strategy allows for a different type of social interaction within the group, where students build software applications from scratch, discovering new obstacles on their path to achievement, and thus allowing for improvement of their skills through self-study.

According to Noreen M. Webb [20], analyzing the expected behavior of a student in a small group learning scenario should be examined following these three key principles:

- 1) the relationship between interaction and achievement;
- 2) the cognitive process and the socio-emotional mechanisms bridging interaction with achievement;
- 3) characteristics of the individual, group, scenario or reward structures that could predict the expected interaction that could, in the end influence achievement in small groups.

The first common behavior that Webb claims has a high probability of leading to success is the helping behavior, with different degrees of help having various outcomes on the achievement, if applied. Summarily, it is expected that the student who offers help to other peers in a small group scenario to most definitely have a positive outcome, while it may not necessarily be the case when we consider the impact of receiving help on the learning process, with only two out of five studies showing receiving help as an important factor that influences achievement, therefore, failing to distinguish between different degrees of help, or needed or unneeded help, may account for the lack of improvement.

With respect to the mechanisms of bridging the interaction with achievement, one method is verbalizing the cognitive process by talking to a peer who is also working on the task, talking to a confederate who should be deepening the knowledge or talking to someone who supposedly mastered the task. Furthermore, the study shows that situations where a student assumes the role of a teacher and explains to other peers a more complex subject seem to be more beneficial for the act of learning, thus allowing for knowledge self-checking and recollection, offering the explainer a chance to produce a more organized cognitive process by preparing to teach someone. Evidence for the efficiency of verbalizing comes

from a study made by Bargh and Schul [21] that compared the achievement of students that were studying for themselves with that of students that were studying in order to pass the information to others.

The unequal distribution between high-ability and low-ability students in a small group scenario may have an impact on the performance of the more competent individuals, if a reward system is not applied. Steiner [22] warns that the above situation can be a decrement in motivation, and a potential danger in all learning groups, because without a reward system to differentiate the highly competent individuals from the visibly less able ones, the more competent ones are inclined not to work at their full capacity.

Building a reward structure has its benefits, especially in small group situations, where student interaction can be improved by implementing a specific reward system. Slavin [23] suggests that group reward is a more significant source of motivation that can stimulate a cooperating behavior between students. Merely recommending or instructing collaboration between members of the group, without implementing any reward system will not produce any student cooperation, especially if helping other students will not affect one's grade, influence final evaluation or other reinforcement.

Nonetheless, the presented results must be reinterpreted when additional variables are added, especially in the distinctive scenario of our proposed implementation of "independent projects" teaching strategy that relies on having productive, active and efficient collaborations between students working in small groups on totally different projects. The question of how interaction in groups promotes learning is still not well understood, but the presented evidence makes a strong defense for the importance of interaction while learning in small groups.

There are seven principal self-study pedagogical approaches that have been identified in the theory of learning, even though they might overlap with each other on various technicalities [3]. First, there is the dogmatic instruction, which has its origins in the religious communities, where learning starts with the contemplation of a certain set of divinely inspired maxims that suggests how one should live.

The second pedagogic mode is a form of expert credentialism, where the model for how one should conduct oneself comes from a profession, guild or specialty and the teaching tool adopted is learning through case studies.

The third pedagogical approach is generally called individual self-discovery, where the learner pursues a path of study that would eventually lead to ultimate satisfaction. This approach may include a variety of learning models, but it is mostly experimental and focuses on contemplation of the self.

The fourth mode of pedagogy is the Socratic Method, where a learner develops an argument about his or her fundamental beliefs, which is challenged by a mentor or teacher, who acts as a disputant, in the process of debate where the learner and the mentor argue from different positions, by challenging the foundations of each other's argument.

Service learning and learning by doing are the fifth and sixth pedagogical approaches, similar in some ways. Learning becomes synonymous with living, and the learner temporarily immerses him or herself in the work or works of the community, providing solutions to social ills or difficulties. The seventh pedagogical mode, life-long learning is an approach through which learning is understood as lifelong and of long duration.

These pedagogical approaches, along with their curricular content do not map directly onto the current array of teaching techniques. In response to new technologies, there is an implicit demand for new learning and teaching approaches, therefore a need for combining the current learning opportunities with the well-known learning approaches.

Today, it is a lot easier to get access to information than it was fifty years ago, with new technologies available, designed to attract new types of students. Since its launch on January 15, 2001, Wikipedia has grown continuously into a very reliable source of information. A range of academic institutions have joined the Coursera network and have developed custom designed and interactive online materials, offering free academic level information to anyone. These new learning opportunities encourage self-study and self-improvement, offering new ways of teaching techniques, one where a mentor or a teacher is not necessary needed.

Preparing students for their future jobs is the main goal of universities. As the world becomes more and more interconnected and the applications, especially in the IT domain, become more complex, the requirements coming from the work spaces are impossible to be handled by a single person. Thus team work is used by many employers. Therefore, universities focus on activities that require collaboration in order to prepare their students for the outside environment, to which they didn't have much connection before university. This approach is investigated in the following section.

B. Collaborative approach

According to Gerlach, "*Collaborative learning is based on the idea that learning is a naturally social act in which the participants talk among themselves.*" [1].

The term "collaborative learning" generally refers to a situation in which a group of students performing at various levels of skill in different fields team up together in order to work in small groups aiming towards a common goal. In a study regarding the role of collaborative learning in universities, Popa, Iosifescu and Popescu [31] identify three general types of collaborative learning work groups by adapting previous research from Johnson, Jonson and Smith [34]:

- 1) informal learning groups as being any group of three to five individuals engaged in discussing a class related question or to check on the understanding of the material;
- 2) formal learning groups where groups of students have a set goal that they need to achieve by working together;
- 3) study teams which are long-term groups that do not need to

accomplish a common goal by working as a team, but provide support, encouragement and assistance in completing course requirements or assignments throughout the course of a semester, usually comprised of individuals who already have a strong relationship with each other.

People working together as a team focus on each other's skills and resources, share ideas and monitor their work. The main idea is that knowledge can be created among members that interact, share experience and take roles asymmetrically [4]. In other words, members engage in a common task but individuals are accountable to each other. The interactions include face-to-face conversations or computer communication (chat, forums, management tools, etc.). Examination is done through conversation analysis. [5]

In a study that analyzed the benefits of integrating an online discussion forum as an extension for the learning process, Mohd Nor, Razak and Aziz [29] found that students were deeply involved in instances of debating knowledge, giving help and engaging in thorough review of the addressed topics, offering evidence that students were involved in collaborative learning by debating topics that were delivered and discussed in class. Another study [30] tackles the idea of better integrating a virtual environment in order to enhance collaborative learning.

By using collaborative learning, people will learn faster and deeper because of sharing thoughts, brainstorming and seeing other perspectives that can improve their thinking styles and facilitate interaction, which will furthermore maximize motivation, a crucial part of learning the skills needed.

According to Kaufman, Sutow and Dunn [19], there are six essential elements of successful collaborative learning:

- 1) Positive interdependence: students should see themselves as responsible group members, each having an important and well-defined role in the success of the team:
 - a) President – for decision-making and role-appointing
 - b) Reader – for reading the materials to the group
 - c) Recorder – records ideas
 - d) Sociologist – for checking the group's interaction
 - e) Checker – for making sure each member is heard or has contributed with ideas
 - f) Encourager – for noticing and supporting good ideas
 - g) Summarizer – for concluding the team's ideas
- 2) Individual accountability: each student's performance is checked either by picking randomly one member to explain the team's ideas, or by grading the assignments solved together, or by asking students to rate others' participation.
- 3) Group processing: students discuss about their performance at the end of the project and try to find three achievements and three things they would improve as a team.
- 4) Social skills: [2] underlined four levels of social skills needed for a cooperative approach to be meaningful:
 - a) Forming skills – being able to organize the team, to assign roles and set a minimum amount of rules for suitable behavior

- b) Functioning skills – keeping a close relation with the team members and completing the assigned tasks
 - c) Formulating skills – being able to understand the flow on information and ideas within the group
 - d) Fermenting skills – being able to add to the information, to debate and form a conclusion
- 5) A specific task: proper explanation about the assignments (how, what etc.).
- 6) Face-to-face interaction.

To sum up, the six elements of a successful learning process require intensive interaction among the members of the teams, constantly sharing ideas, taking different roles such as recorder or summarizer, discussing collectively about the team's performance or being individually accountable for assessing others' performances.

C. Anarchy - the mixed approach

While analyzing the complex responsibilities and duties of a head of college or university within the United States, Cohen & March [25] use a different approach in describing organizational behavior in complex organizations like the American colleges or universities and propose a new class of organizations that can be referred to as organized anarchies.

Cohen & March describe an organized anarchy any organizational setting that has the following characteristics:

- 1) Problematic goals. The organization does not have an input set of goals that can satisfy the consistency requirements of theories of choice, thus making the organization appear to operate on a variety of ill-defined preferences.
- 2) Unclear technology. The organizational process is somehow confusing, it does not understand its own processes, operating on the basis of trial-and-error procedures.
- 3) Fluid participation. The participants can vary among themselves regarding the time and effort they dedicate to the organization.

Giesecke [26] proposes the idea that universities are prototypical organized anarchies and follow the concepts Cohen & March (1986) have previously proposed. The main arguments refer to the vagueness of the institutional goals, which in some cases are rarely understood. The major participants in the organization are constantly changing during the process of organizational activities and decision-making opportunities. The settings include an administrative hierarchy blended with individual faculty entrepreneurial behavior.

Larsen, in [6], studies an anarchic way of managing/organizing Oticon, a Danish company that sells hearing aid equipment, and which needed to have its structure reorganized. The CEO's desires were to create such a nourishing system that each person, no matter what skills he or she had, would be able to fit in all kinds of projects and develop their skills to suit various situations.

The author writes that the company's structure was drastically modified: the managerial jobs were split between the headquarters and the rest of the company. In addition, the CEO had the greatest power and there would be no HR department whatsoever.

This company format provided, as the author says, jobs for many people (since a single person would be considered fit to engage in multiple kinds of projects), but not for everyone.

Besides the human resource related changes, a lot of other adjustments had been made (the offices had been moved to another building, where the employees would occasionally bump into each other, they had built open space rooms where people would collaborate, rooms where employees could read their important emails and valuable documents would be scanned and then shredded).

After these changes, the company became rather flourishing and met a substantial profit and development; albeit some of the people who worked there were not the most pleased employees.

Some of them would say the new structure is interesting and designed to ease their path through the company (hence they wouldn't have to worry about progress or about promotion since the entire firm was divided into two major jobs – CEO and “rest of the company”). On the other hand, some employees were not so delighted about the chaotic groups that were formed during this process. Many of the people working in the Danish company complained about not having the possibility to advance, to be promoted, nor did they agree with the “work is not given, it is looked for” standard.

While analyzing the principal types of decision-making models used in software development projects, Kousholt [27] described an anarchic model as a case that is not covered by standard analytical or political models and where the outcome is determined by chance or other external influences. The study presented two anarchic models that fit Kousholt's description of an anarchic model.

The first anarchic model is called Lindblom's muddling-through model, proposed by Charles Lindblom, a professor of economy and political science who was inspired by the decisions made in connection with public-sector budgets in the USA. The advantages include the simplicity of the method and the efficient use of the time resource. This method is characterized by realism because small changes can be handled with ease by decision-makers. A disadvantage is that the overall picture of the project fades into the background, due to the lack of an in-depth debate.

The second anarchic model is called the garbage can model because the opportunity to make a decision is viewed as a “garbage can” into which the decision-makers “put” all kind of different tasks, problems and solutions that do not necessarily have a connection, but the problems tend to find their solution, or fail following anarchic paths.

As Kousholt [27] pointed out, the moral of the garbage can model is “that it is necessary to be open and specific about problems and «throw them into the garbage can» where other decision-makers can see them – and perhaps a solution will crop out one fine day!”

The anarchic approach, also known as chaotic management style, has been popularized around the world by the multinational company Google [7]. The company believes that

the full potential of the employee is achieved when he is given free hand in setting and achieving goals. [8]

The type of leadership followed by Google is similar to Laissez Faire, also known as delegative leadership [9]. In this leadership style, managers are not involved in the decision making process and leave this task in the hands of group members. This style is characterized by a low level of guidance from leaders whose primary purpose is to provide the tools and resources needed and a complete freedom of decision for employees, that are expected to solve problems on their own.

Laissez Faire leadership style is thought to be effective in groups consisting of skilled, motivated and members able to work on their own, since this type of employees own the skills needed to accomplish tasks with little guidance. When group member possess a high-level of passion for their work, this type of management can make them feel more satisfied with what they achieve.

This type of leadership is not suitable when team members don't have both managerial and technical skills and it doesn't fit all types of people. When the employees are not good at managing their own work, without the help or feedback of a leader, the follow-up of the project may be a failure. The fact that the manager is not very involved in the project may influence other team members that may begin to care less about it.

Management specialists from the website Bloomberg BusinessWeek [10] say that Google's approach is to admire and to learn from. Their system ensures some degree of attention even for the ideas that are not the best fit for the company's capabilities. Nevertheless, 95 percent of Google's revenues still trace back to the Web-based search advertising and not from their other projects.

In order to improve their management style, the company came up with a plan called Project Oxygen in the early 2009, which was meant to "build better bosses" [11]. After conducting a series of surveys, feedbacks and performance reviews, Google came up with 8 qualities that a highly effective manager should have. They came to the conclusion that the best managers are those who lead by asking questions and not by dictating answers and take interests in employees' lives and career.

Those 8 habits an effective manager should have are the following [11]:

- 1) *"Be a good coach"*
- 2) *"Empower your team and don't micro-manage"*
- 3) *"Express Interest in employees' success and well-being"*
- 4) *"Be productive and results-oriented"*
- 5) *"Be a good communicator and listen to your team"*
- 6) *"Help your employees with career development"*
- 7) *"Have a clear vision and strategy for the team"*
- 8) *"Have key technical skills, so you can help advise the team"*

But Google is not the only company that has adopted this style of management. Other well-known firms, like GitHub or

Valve use this kind of leadership.

GitHub is considered to be a well-known example of anarchic management that has a non-hierarchical approach towards working, anarchic but with clear goals. Their policy is: *"Anarchy works wonderfully in a small group of individuals with a high level of trust. Everyone at GitHub has full access and permission to do whatever they want. Do great things and you earn respect. Abuse that freedom and you violate everyone's trust."*

Therefore each employee can work on whatever they want as long as they ensure that everyone else is up to date with the current status of the project [24].

Brandon Keepers, GitHub employee, has stated on his web site that working there is amazing [12]. He talks about how everyone is encouraged to work on something that interests them and also benefits the company. Regarding anarchy he says that it works best in a small group of individuals with a high level of trust and how doing great things earns you respect but abusing your freedom violates everyone's trust.

The employee handbook released by Valve Software shows that it has a unique corporate structure rarely seen at such a large company: it has 300 employees but no managers or bosses at all [13].

In an anarchic organization, programmers choose their own work at the beginning of the day, during the daily meetings. Because there are no project managers, testers or other common job positions that can be found in a typical common management hierarchy, all the rules that govern the managing of software development are completely changed in this particular professional environment. These changes aim to make the programmers lose the "fear of failure" by giving them free hand to develop and take total responsibility for the success of each project in a form of self-organized "anarchy".

Somehow, a self-organized anarchy tries to make individuals change their source of motivation especially in the learning process and avoid any type of fear that might still unconsciously be remnant from childhood (the fear of receiving a bad grade, the fear of failing a class, the fear of failing to live up to the parents' expectations) and which can negatively influence one's decision making as an adult. Individuals that during childhood had most often been motivated by fear of failure might not be able to perform well under the circumstances of receiving liberty or when they are required to make choices of their own and speak their own mind, because, subconsciously, they are still waiting to receive some sort of confirmation for their actions from a more competent individual.

1) Anarchy and education

Education has been taken into consideration since the beginning of anarchism.

English enlightenment anarchist, William Godwin [14], said that education should have a respect for the child's autonomy and it should be built on the person's own motivation and initiatives. German philosopher Max Stirner said that other ideologies "are concerned with the learner as an object, someone to be acted upon rather than one encouraged to move

toward subjective self-realization and liberation" and that for him "pedagogy should not proceed any further towards civilizing, but toward the development of free men, sovereign characters" [15].

The first school that can be considered to be democratic is the one opened by the famous novelist Leo Tolstoy in Yasnaya Polyana and can be considered the forerunner of other such democratic schools [16]. Tolstoy differentiated between education and culture, saying that the first is the tendency of

one man to make another just like himself, that education is culture under restraint and that without compulsion, education can be transformed into culture [17].

In 1921 Alexander Sutherland Neil founded the independent British boarding school Summer Hill School, on the basis that "the school should be made to fit the child, rather than the other way around". The management is similar to a democratic community. During school meetings everyone can attend and has an equal voice [18].

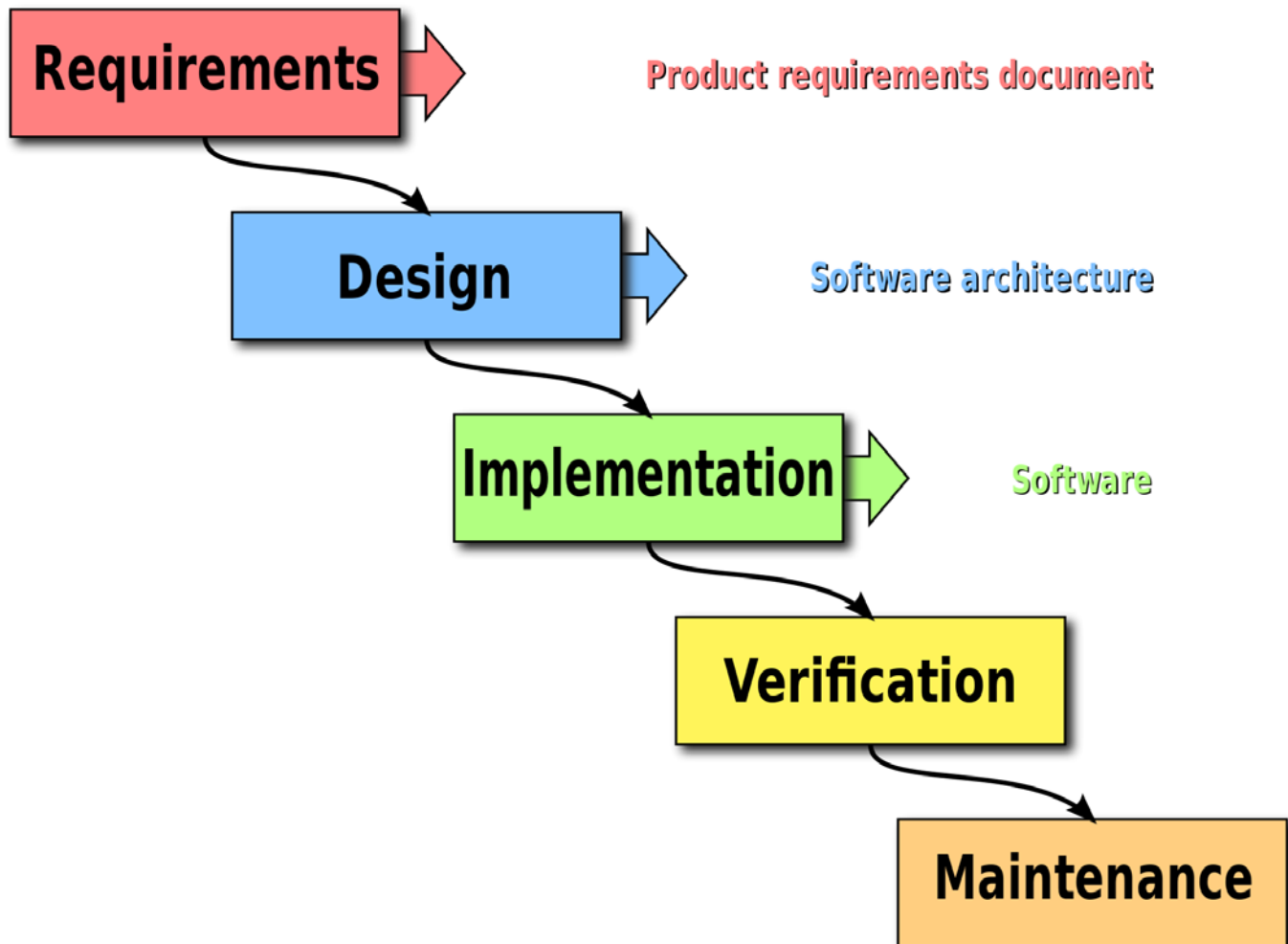


Fig. 1 Software Development Process

In educational institutions that are based on programming or which are connected to engineering environments, implementing an organized anarchy approach for large scale projects could be beneficial for the learning process. Thereby, the role of project manager is taken by the coordinating professor or the teaching assistant who puts forward a task or a given problem that a selected group of students have to solve. The lack of job titles makes every individual feel equal to another, and thereby equality becomes a valuable key factor in solving tasks. Because the students involved may have different skills or affinities, the garbage can (Fig. 1) method can work better, having the project divided in different phases, added to the garbage can so students can choose which sub-

group fits their skills best (one person can belong to different sub-groups).

III. TESTED APPROACHES

A. Basic Independent Approach

In order to have a reference, the first approach tried was the classical independent approach. The experiment took place in the first semester of the academic year 2009-2010 within the Software Project Management Course from "Politehnica" University of Bucharest.

The students chose a project from a list of ten by submitting their resume along with a project proposal where they defined

how the project would be structured. Each project had its own level of complexity, varying from implementing games (Mortar Mayhem, Battleship) to practical applications (Image Analysis, E-Commerce Lite, Multiple Choice Test Application), therefore the more experienced teams were given more difficult assignments than the less experienced ones. Seven small teams, with 12-13 students resulted. Each student chose his/hers part in a project. Most of the teams opted for more or less the same composition, as shown in Fig.2.

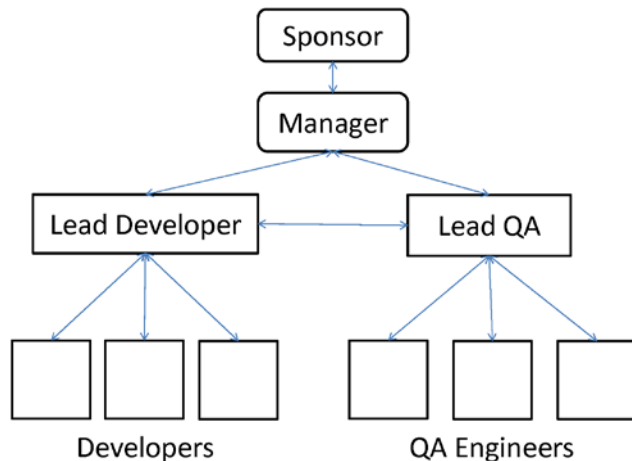


Fig. 2 Simple internal group structure used by the most of the team

All the teams had their own project manager who was responsible for the entire activity: taking decisions, supervising the team's progress, making sure that the goals are met and motivating them. While the role of lead developer and lead QA was given to the most experienced member in that specific field and their main tasks were to guide and assist the developers and also report to the PM about the status of the project, the developers had to implement the project and the QA engineers had to check the functionality and report constantly back to the lead QA.

During each lab, the students respected the milestones and presented the evolution of the project's stages:

- 1) Initial phase – the project starts, the terms of reference and the team are established;
- 2) Planning the project – resource plan, budget, communication plan;
- 3) Execution – in which the product is obtained. In this phase there is also a quality check, risks, problems and the area in which the project would fit best;
- 4) Closing – delivering the product to the client and making a final analysis upon the project.

In case the students wanted to do their assignments before the deadline, their grade would suffer because, in order to acquire a high grade, they had to interact with the team members and meet the milestones according to the schedule.

Each student worked independently as they had a personal grade that contributed to their final grade. Working individually, the students have brought their personal contribution, through their personal experience, and originality as well, in order to realize the final project.

The final grade was obtained at the end of the course as follows: 60% - acquired during the semester (50% - assigned for the project, 10% - laboratory activity), 40% - written final exam, which means that the student would not be able to receive a high grade if he/she wasn't constantly involved throughout the development of the project.

B. Basic Collaborative Approach

For the collaborative approach, in the year 2012, at the Software Project Management course, students had to develop a project to transform old written documents, such as books, newspapers, map, journals, etc. into electronic documents (i.e. PDF, RTF). The project was broken into several components:

- 1) Pre-processing
- 2) Binarization
- 3) Layout
- 4) Paging
- 5) OCR
- 6) Hierarchy
- 7) PDF-exporter

Every team had to make a component that would later be integrated in the project. To stimulate the students in doing their job, the grade for each student would be divided as such: 60% of the grade will be based on the performance of the whole project and 40% would represent the work done individually. And also to make sure that all the students participated in the project, it represented 50% of the course grade.

The complexity of the project simulated working in a company where a single division of employees cannot finish a task in a suitable amount of time. An automated system used to analyze and extract information from different documents is a highly complex piece of software capable of multiple applications.

Learning was meant to occur as a result of the interaction between peers engaged in a competition of solving the tasks at hand. The students were split into ten groups of five to seven individuals and encouraged to 'work' in groups, rather than 'be' in groups, thus playing a significant role in each other's learning. This is a typical scenario of interaction between group members that is applied in practice by software companies where different teams of individuals are formed in order to solve different interdependent tasks.

C. Proposed approach - Anarchy

The project had the goal of implementing a board game. Its purpose was to make the team one played in win, by protecting any of the team members and creating a fast path for one of the members to the destination, the other side of the board. The players were pawns, consisting of code, each student had a single pawn and he offered a unique code for the pawn (no two students/pawns had the same code). Each member had an initial team but during the game the team composition would randomly change. The final score was based on the points that the initial team would gather but also on the points the pawn would win while playing in any other team. Because of this,

every team member implemented the team's strategy but could also have its own strategy to maximize the individual score. This approach could even lead to treason.

This anarchical approach is well suited for students who have a solid knowledge in the domain and former experience with a similar approach and who can foster a high level of motivation. It is not a good choice when the aim is to tackle new knowledge, but that was not an issue for the students who took part in this project since they had to use their skills of computer programming in order to implement their given tasks.

1) *Project management schema*

The concept was simple: students were given a task and were divided in teams. The team came up with a strategy but all students were given free hand in their implementations. They could even choose not to follow their initial team's strategy and just go with their own.

This is the main characteristic of the anarchic approach: freedom of the individual. No strict guidelines, no fixed milestones, just do what you want and how you want, as long as it solves the problem. Its main goal is to make people work with pleasure while the whole project is benefiting from this approach.

Compared with other managerial approaches, anarchism does not have a strict role division.

In this school project, every team had a manager whose only role was to conduct the team meetings and whose voice was equal to any other from the team. He wasn't the decision making entity, he was just a mediator between team members.

The teacher was the one who evaluated the output of the project but during its development his role was not to lead but to guide. He offered the environment needed by the students and gave advice but he didn't impose anything (such as strict milestones, ways of approaching the problem). There were two types of teachers: one that gave a hundred percent free hand to the students and one that imposed some level of control by setting milestones for the team members. Looking at the grades, one can see that one of the teams that received the highest grade and the team that received the lowest one were both guided by a teacher from the first category.

1) *The development plan*

This kind of managerial approach is designed to encourage innovation and free thinking and helps students develop their own ideas. It can lead to a more objective way of grading them, the finished work being mostly theirs. This cannot be obtained using a collaborative style, where the final project is the combined effort of a whole team (in this case it's hard to track each individual's work).

This project had a unique way of grading students that made the team's effort as important as the individual one. The final grade was obtained by multiplying these two. Looking at the final grades, one can see that those obtained by students who took part in this project were lower than the ones obtained by students that had to use different approaches in other years.

II. CONCLUSIONS

The independent approach not only generated a quality final project but it also provided satisfaction, according to the student's feedback. Through this approach, even the laziest of the students can get involved.

However, it was the collaborative approach that generated the higher grades, but probably because the students managed to hide behind their harder working team-mates.

The anarchic approach is generally best used for students who have knowledge in the domain of the project and have a high level of motivation. This topic wasn't an issue for the students taking part in the project, since they had to use basic knowledge of C++ language in order to implement their task. Most projects that are carried out in school most of the time involve individual work and, maybe, sometimes, some sort of collaboration with other peers, but an anarchical approach is rarely used.

One of the biggest issues the students encountered was trying to elaborate a team strategy. Because none of the team members was a decision-making entity they had a hard time agreeing. Each person had their own ideas and tried to impose them and every time they thought they found a middle way, somebody would come up with an idea he thought was better. As the grades show (the team grade was, in most cases, lower than the individual grade), this was the biggest weakness. The existence of an entity that had the final word in this decision process would have made this step easier for everybody.

The topic of motivation may also be a problem. If the only motivation is getting a higher grade this might not be the best solution for all students. Thus other motives are needed, for example the subject being fun to work on or the prospect of using the project in the future.

The problem of motivation was really well depicted in this project. The students were excited at the beginning of the semester by the idea of implementing a game and competing against their colleagues. In contrast to the independent project, which students just wanted to get finished as fast as possible, the anarchic approach generated a large number of different ideas: The game strategies for this year project spanned from paths of movement, estimating adversary movements, alpha-beta pruning and more, which shows this is a great approach for stimulating individual engineering abilities even if working in groups. The groups stimulated this burst of ideas from the talks undertaken during the meetings.

The conclusion to be drawn is that the two similarly opposite approaches can be merged and the result can be considered a new, different approach, but certain measures have to be considered, like the existence of a decision taking entity, a powerful motivating factor and careful and objective individual and team grading in order for it to work.

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