

The Archetype Learning Method - Scaffolding Teamwork Competences in the Engineering Classroom

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Abstract—Globalisation of both the workplace and higher education is a fact for many Universities and Industries. For the universities the challenge lies both in identifying the needs and developing pedagogies suitable for preparing their students to become a workforce that can contribute in a global economy. Thus, a central issue is how to provide an appropriate level of background knowledge and skills which contribute to the success of the individual in the workplace, and to the success of their employers.

Helping students develop the skills required for success in global software development teams provides a number of unique challenges and opportunities for the designers of engineering degree programmes. A central issue is that students bring with them local cultural norms, different native languages, and rhetorical traditions, which place an additional burden to the already difficult task of working effectively in a student engineering team.

The contribution of this paper is the presentation of two learning activities; 1) structured role-play and 2) hypothetical archetypes, used within a method we call the "Archetype Learning Method" (ALM). The activities are geared towards enhancing the students' awareness of the underlying complexities inherent in participating in global software engineering and through that provide scaffolding to the development of teamwork skills.

Our method provides students with strategies for engaging more productively in teamwork in a global context, hence contributing to the systematic development of one of the critical professional skills identified in the CHAOS report.

I. INTRODUCTION

Globalisation of both the workplace and higher education is a fact for many universities and indus-

tries [1]. For the universities the challenge lies both in identifying the necessary work place competences and developing suitable pedagogies which prepare their students to contribute as a productive workforce in a global economy. A central issue is how to provide graduates with an appropriate level of background knowledge and skills [2], [3], which contribute to the success of the individual in the work place, and to the success of their employers. Helping students develop the skills required for success in global software development teams provides a number of unique challenges and opportunities for the designers of engineering degree programmes.

The complexities involved in functioning in a global software engineering team are considerable. Among them the reality that students bring with them local cultural norms, different native languages, and rhetorical traditions, which place an additional burden to the already difficult task of working effectively in a team. The contribution of this study is the presentation and evaluation of a method to address some of these educational issues, with a focus on scaffolding the development of teamwork skills.

Critical awareness in global software engineering naturally concern purely technical complexities, but also of high importance and the focus of this paper is the many aspects of diversity in global teams. Compelling evidence of the need to more comprehensively address this issue can be gleaned from the CHAOS report produced by the Standish group

annually since 1995 [4]. The 2015 CHAOS report is a systematic meta-analysis of 50 000 software engineering projects for success and threat factors. One of the conclusions of that report was that emotional maturity is one of the four most important factors of success for software engineering projects. The Standish group defines emotional maturity as “the collection of basic behaviors of how people work together. In any group, organization, or company it is both the sum of their skills and the weakest link that determine the level of emotional maturity”.

In our project courses the main educational goal is to provide students (our future engineers) with strategies for engaging more productively in teamwork in a global context, developing the professional skill identified as a key success factor in the CHAOS report. This paper focuses on global teamwork skills, since this is one of the most important aspects of running successful projects.

As a part of this effort we developed the “Archetypes Learning Method” (ALM). This paper explores how two learning activities 1) structured role-play and 2) hypothetical archetypes of students can be used to enhance awareness of the underlying complexities inherent in participating in global software engineering. These methods are applied in structured reflection activities in a two course sequence in our Information Technology Engineering programme at Uppsala University, Sweden.

Our method provides students with strategies for engaging more productively in teamwork in a global context, hence contributing to the systematic development of one of the critical professional skills identified in the CHAOS report. The remainder of the paper is structured as follows. Section II describes the background, and challenges which were the drivers in developing the ALM approach. Section IV provides an overview of the activities included in the method, explores staff and student perspectives on the use of the method in teaching, and discusses the evaluation data we have collected. Section V provides recommendations and outlines future work.

II. THE 21ST CENTURY CHALLENGE

Over the last decade project and problem based learning has emerged as an important component of much of engineering education [5]. Project and

problem based learning environments have also been the focus of much research in higher education [6], and are widely claimed to contribute to development of both professional competences such as teamwork and communication [7], [8] and twenty-first century skills [9].

The initial data which forms the background to the current paper was collected in 2008 [10] and revealed a strong tendency among students to focus on utilising existing strengths in teamwork situations. This indicated that students were choosing to sacrifice many learning opportunities in student teamwork in order to optimise the quality of the desired project result or artefact, rather than taking the opportunity provided by the project to develop new skills and competencies. This behaviour was also linked to student’s concerns about optimising their time usage in the course, and a desire to complete projects as quickly as possible and often with the minimum effort required to pass.

As a result of the insights we gained in this research we commenced a series of reforms in our degree programme curricula [11]–[14]. The implementation of these reforms included restructuring several courses to provide a clearer focus on developing skills that had previously been under emphasised. We also changed our assessment approach to focus more on rewarding students who exploited opportunities for professional development and and reducing the rewards associated with the technical sophistication of the final product [15].

Peters [16] reports results from a critical incident analysis focused on understanding why students in a project course expressed a strong conviction that spending time on understanding a complex problem set in a societal context was a waste of time. A number of the students in the class reasoned that their task as professionals was to solve well defined problems that someone else had specified for them. Spending time on working out how to collaborate in a semester-long international student collaboration project was also seen, albeit not as strongly phrased, as wasteful, where, again, it was seen as someone else’s problem to sort out. They were also of the initial view that the main challenges with project work in a team environment were technical rather than social and cultural.

Further data collected in the subsequent year in

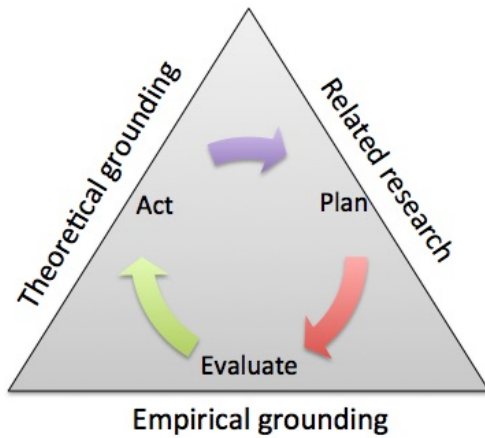


Fig. 1. The ALM Development Process

15 minute individual teamwork debriefings indicated that many students failed to appreciate some types of workplace skills that would likely serve them well outside the academy. In particular students evinced a very strong belief that their future work would consist of well defined technical tasks for which a single optimal solution could be devised, and where their employers would know the "proper" way to arrive at this "correct" solution. Albert is an excellent example of this type of view.

Albert: "It was a very interesting project, really fun, but very unrealistic!"

Interviewer: "Really? In what way unrealistic?"

Albert: "Well, you know [pause] well, like when you are working in a company your boss will know exactly what needs to be solved technically. I mean this whole fuzzy problem thing, it isn't really something that a real company can tolerate. They know what is to be done and exactly how to do it. So I don't see why we wasted time with you pretending that you didn't know the exact problem to be solved."

III. THE ARCHETYPES LEARNING METHOD (ALM)

A. Developing the ALM

To address the specific challenges posed by culture and background on teamwork and software systems design we developed the Archetype Learning Method (ALM) and devised a series of associated

learning activities which were incrementally introduced into a two course sequence in a five year engineering programme in information technology engineering Uppsala University, Sweden.

The ALM was developed iteratively and evolved from classroom interventions and observations. The personas element draws heavily on related research in human computer interaction [17]. While the scenarios are drawn from our work on project team dynamics and, related theories from computer science education from our action research context. The elements of the design process are depicted in Figure 1. Our empirical data consists of a detailed case study and also analyses of reflections gathered during several instances of two global software engineering [11], [14], [18] courses that have been offered at our institution over the past decade.

B. The ALM Structure

To help students focus on the design challenges inherent in working as an IT professional the ALM method provides two separate, but interrelated, modules. The structure is shown in Figure 2. Fictive student archetypes (implemented through our student persona sheets) provide a mechanism to facilitate awareness of others, and other cultures and norms. The role-play sheets provide scenarios that leverage these norms to simulate situations that place students in roles they might otherwise never encounter. These theatrical situations are used to stimulate reflection on key areas which are challenging in teamwork.

The process involves a period of role-play, which is then followed by a period of staff facilitated and guided reflection. This provides the staff with an opportunity to introduce relevant theories and leadership and teamwork concepts. For instance the leadership scenarios can be used to explore tacit and explicit power, delegated power and informal leadership approaches. Passive resistance strategies and other teamwork strategies can also be explored in this way.

C. Applying the ALM in Instruction

The ALM role-play module targets cultural norms for communication and negotiation in teams by defining archetypes with which students interact in role-play.

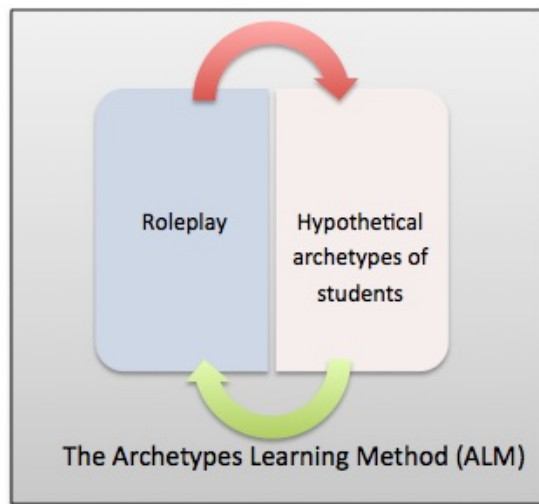


Fig. 2. ALM Structure.

The 1DT092 - Global Software Product Development (Runestone) course at Uppsala University is a collaboration between Uppsala University, Turku University of Technology, Finland, and the Hanoi University of Science and Technology (HUST), in Vietnam¹. The course has been running since 1997 and has involved a number of other universities over its lifetime, including Rose Hulman Institute of Technology and Grand Valley State University in the USA and Tongji University in China. The course is 10 ECTS credits and runs for approximately 11 weeks. In this course development teams are allocated 3-4 students from two of the participating sites. Each team thus consists of 6-8 students who are asked to produce a prototype of a distributed system which is capable of steering a remote robot in real time both autonomously and under direct human control. More information about the course can be found in our publications that describe aspects of the course [11], [19], as well as on the course web site, which is hosted in the project management tool RedMine at www.runestone.it.uu.se.

The role-play exercise in the Runestone course was introduced in 2014 as a result of student feedback on the annual course evaluation. Students observed that they felt a need for more scaffolding in terms of dealing with challenges stemming from the course demands on competence in leadership,

collaboration and inter-cultural communication.

To address this we introduced a course presentation dealing with formal and informal power and leadership strategies. The formal instructional session on leadership is complemented by the role-play exercise presented here. The scenario provides a staged exploration of intra-team dynamics from team formation and goal negotiation, through to internal conflict resolution and challenges associated with failure of some members to pull their weight.

To emphasise the cultural components and to help students gain awareness of the power and limitation of cultural stereotypes each student in the role-play exercise is given a fictitious character to play. The characters are simplified student characters which combine both student and cultural stereotypes. These characters are included for reference in Appendix B.

The scenario sheet presented in Appendix A provides the overall structure of the 90 minute classroom role-play session. Student are briefed on the purpose of the exercise and the intended aims for about 10 minutes at the start of the session. The remainder of the session consists of alternating periods of role-play and scaffolded reflection. Each role-play element is played out in the student groups for between 15 and 20 minutes. This is followed by a series of reflection questions from the facilitating staff member which draws on the different experiences of the groups. These sessions are typically conducted in an active learning space with group table setup. The facilitator gathers input on what happened in the role play from each group, and uses that to discuss strategies for dealing with the range of situations that can arise.

The archetype method is used in the subsequent course, 1DT012 - IT and Society², and it utilises character sheets developed based on persona stereotypes [14], [20]. The IT and Society course is a collaboration between Uppsala University, Sweden and Gannon University and Rose Hulman Institute of Technology, both in the USA. The course is a large scale international project course in collaboration with the Uppsala Academic Hospital, one of the largest medical training and research

¹<http://www.uu.se/en/admissions/master/selma/kursplan/?kpid=31373&type=1>

²<http://www.uu.se/en/admissions/master/selma/kursplan/?kpid=31021&lasar=17\%2F18&typ=1>

hospitals in Sweden. The focus of the project is on understanding the challenges of IT deployments in the health-care sector and working directly with personnel from the Academic Hospital in current IT deployment projects.

Appendix A shows a sample sheet used in the course. These personas are derived from the researchers' many years of observation of students taking the course. A subsequent pedagogical development project took an action research approach to developing and evaluating these sheets, and involved students in the process of creating personas. The archetypes represented by the personas were developed to make cultural differences, and differences in level of ambition, more visible to course participants, with the intention of facilitating better teamwork in the course project. These characters have subsequently been used to develop and prepare students in two offerings of the course. Related research relevant for this work is the personas method in human-computer interaction [17] as well as our earlier research on the development of global software engineering skills [14].

The archetype method has been used in two course instances of the IT in Society course, which follows the Runestone course described above. In the IT in Society course Archetypes, and the student's earlier experiences collaborating with students from abroad in Runestone, are used as a base for discussion of barriers and enablers for teamwork in global software engineering. In these course instances the archetype personas was presented to a small group of students who discussed the following questions.

- What do you think of this persona? Is it realistic?
- What can the project group do to motivate this person?
- What can the leader do to motivate this person?
- What can this person do himself/herself to be more motivated?

During the seminar each of the personas was discussed separately at the same time as the faculty summarised the suggestions into mind maps with possible actions to take for each persona.

D. Evaluating the ALM

There are two separate results of this research. The first, and most concrete, result is the archetype learning method (ALM) itself. ALM provides structure and guidance for creating learning environments suitable for developing skills in global software engineering at the same time as it functions as a framework for development and refinement.

The second result is the insights reached in the process of developing ALM. These insights are based on our analysis of observational data from student role-play sessions, and reflective texts produced during the courses. We contextualise these results and frame them within the scope of our current experience with scaffolding global software engineering competencies to provide insight into both the strengths and shortcomings of our approach. A valuable "side-effect" of our research is a characterisation of the manner in which students respond to challenges in global engineering teamwork based on our analysis of student insights and examples of the types of strengthened capabilities that can be developed.

We asked the students about the value of the archetype personas exercise in our anonymous midterm course evaluation. On a scale from 1 (not valuable at all) to 5 (very valuable) the exercise got a medium of 3,7, with 22% stating that it was very valuable. The following comment identifies one of the major weaknesses with the approach; "It was nice to do, but lacks follow-up or concrete action plans for when this happens.". While this is true, there is seldom a single manner in which to handle these types of situations, and exact concrete advice with universal applicability is hard to provide. One other interpretation of this type of statement might be that it results from a student desire for the staff to handle these type of problems for them. The student perspective varies however, depending on the type of team role the student finds themselves in. Our staff have observed that the interaction with the students, especially the project and group leaders, is often at a higher level. This has allowed a more nuanced discussion about for instance teamwork and issues stemming from cultural differences

Each student in the Runestone course writes a weekly reflection about the course activities, and

their perspectives on the project as a whole. Henrik's reflection provides a direct student perspective on the role-play exercise.

"In this lecture we did two interesting role plays. In different groups each of us got a different character and we had to play this character in two different team meetings. In the first virtual team meeting we discussed about a project leader and project goals, while the second virtual team meeting was about a free-loader, where we discussed about one team member that doesn't work that much and we are supposed to find a solution. It was quite interesting to play such a role and see how the other students react. In addition, it was nice to guess what was written on the other role instructions. I think such role play helps for solving problems later, since it trains to feel and think how another character thinks and what problems they might have. Since it is necessary to get often a compromise between different opinions."

IV. CONCLUSIONS

This paper provides guidelines for helping students to develop successful strategies for global software engineering teamwork. The role-play exercises and an example of the archetype cards we have developed are provided in the appendices. Full materials for the ALM are available from the authors.

Our research suggests that role-play and archetype exercises contribute to enhanced teamwork competence and students (and engineers) ability to negotiate the challenge of global software engineering. The evaluation data confirms that students gain value from the model, though not all students find it a comfortable exercise to engage with. While learning based on discussions of scenarios might not be as efficient as experiencing the scenarios as lived experiences, they still provide an effective avenue for learning and understanding.

It is crucial to note that learning activities, such as the ones presented in ALM, need to be both accepted and appreciated by both students and faculty in order for them to be sustainable. Staff in

our project courses appreciate the ALM, especially since the learning activities were easily carried through and were perceived as creating a positive and active learning environment for the students. Students are not universally positive to the approach, but in many cases students, such as Henrik above, also clearly appreciate the model and associated exercises and reflect on them in a constructive manner.

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V. APPENDIX A

Background

Your team consists of between four and six participants for the teamwork role-play exercise. The objective of the session is to attempt to understand and act out some team scenarios and reflect on what strategies can be used to deal with situations that arise in teamwork.

Scenarios

Scenario 1 - Team Goals

Your team has just formed, and during the first meeting you have been asked to elect a team leader, and discuss initial plans and work schedules for the project. As the discussion about the project progresses the topic shifts from discussing the technical aspects of the project, to who will be the team leader, and what final grade the team should aim for.

Reflection

What happened in the discussion?
 What power strategies were used?
 Did any character dominate, or influence the outcome? How?
 What grade did the team decide to aim for? Why? How did you reach that decision?

Scenario 2 - Project progress

After about four weeks of the project things are starting to feel very disorganised. No-one really knows what anyone else is doing, and project progress is hard to measure. The team leader (see scenario 1) has called everyone to a meeting to discuss the situation, and to sort out how to solve the problems the team is experiencing.

Reflection

What decisions were reached?
 What were the hardest aspects of the situation to deal with?
 What might have been done differently?

Scenario 3 - Freeloader

The team is now more than half way through the development cycle, and it appears that some of the team members are hardly ever present on campus. The members who have not been present are out of contact and unsynchronised with the rest of the team.

Spend a few minutes role-playing around this question using the roles and characters you have been given.

Reflection

What did you discuss?
 What strategies were suggested in order to deal with the problem?
 Was consensus reached?
 To what extent do you believe the suggested strategies will really work and result in change?

VI. APPENDIX B

Characters

Josephine

Josephine is a Swedish student from the Engineering programme in Information Technology. She is living close to campus, and is very keen on programming and technical aspects of computing. She doesn't feel comfortable in long discussions, and would rather get down to the real work as soon as possible in order to make rapid progress. Discussion is usually a waste of working time according to Josephine, and she tries to participate to a minimum in meetings. She is an ambitious student with very good grades, and sees this course as a way to show off her technical competence and get a high grade.

Jonas

Jonas is interested in systems design and human computer interaction. He has chosen the course because it seems to involve aspects of understanding how systems will be used, including requirements analysis and interface design. He is a little unsure about how good a programmer he is, though he has received top grades in all his programming courses. After reading about the course he thinks that some of the teamwork and coordination aspects of the course seems very interesting and would quite like to have a role like team leader, or meeting coordinator during the project. The final grade is not so important to Jonas, gaining useful experience to prepare for working life in his startup company is his major goal.

Yuen

Yuen is on exchange studies from China. He is a top student from his home university, where only the most outstanding students (those with the best grades and overall academic merit) are chosen for exchange studies. Yuen is unsure of his English, and speaks as little as possible. He is also unsure how he measures up to the Swedish students in terms of competence and management skills. He would not question authority, such as a group leader, and does not want to let the team down, even when he is not sure of what to do. When he does not understand what is happening he just says, "Yes, Yes, definitely!" and smiles politely.

Mona

Mona is not sure that this is the right course for her. She is a perfectionist, and likes to master all the details of every situation in order to work out what the optimal solution should be. She feels that most difficulties are best solved through meeting and discussing at length what to do. However, once a plan is made she becomes very angry if someone disrupts the plan, or an event she was unable to foresee changes the situation. Her plans are perfect, and everyone should follow them to the letter. If she decides that this is an interesting course she will engage very actively and try to plan the entire project. If she concludes that things are not working out, she will first try to make everyone in the team work harder to fix the plan, and if that does not seem to work become disinterested in the project and stop contributing. For her the final grade to aim for will depend on her engagement.


Sverker

Sverker lives in Stockholm and works part time with his own games software company. He is very sure of himself, and has selected the course because it seems possible to participate via the Internet pretty much for the whole course. There are few scheduled classes in Uppsala, and most of those don't look like they will be very interesting, so he plans to skip most of them. Perhaps he might go to the first one to meet the lecturer and the other people taking the course this semester. The plan is to spend as little time as possible on the course, and to make the minimum effort needed in order to pass.

Tapio

Tapio is a Finnish student taking the course as part of his degree in Finland. He is a good communicator, and keen to be a part of the project. He is concerned that the collaboration from a distance will present challenges, since he is the only Finnish member of the team, the other four members are from Sweden. His technical skills are quite strong, but he is quiet, and only contributes to discussions if he feels that he has something really important to say. He would quite like to be team leader, but wonders if that would be possible, when all the rest of the team are in Sweden.

VII. APPENDIX C



PERSONA #3

LISA ANDERSSON

STATE OF MIND

Lisa is happy that the other students trust her enough to select her as project leader. She thinks that will be a good experience for the future. Lisa believes her experience, being a 5th-year student at the IT program, was one reason for selecting her to the post. Now she wants make her group proud.

USER SCENARIO

Lisa has already selected the competences she would like to develop. She is also the project leader of the entire team. Therefore, she would like to read a book on leadership and wonders where she can find some good titles. She knows she also needs to focus on the other competencies she has chosen, especially improving her writing skills and therefore she has not got time to read more than one book on leadership. She thinks it is difficult to determine if a book is relevant to her.

PROJECT ROLE

Project leader.

GOALS

COURSE Get experience from an international project and improve writing skills

FUTURE Work as a project leader in an international company

NEEDED SUPPORT

Find ways to develop competencies in professional skills, communication skills and international perspective.
Find reading material connected to the competencies and determine its relevance.

ABOUT

26 years old
Female Swedish
Studying last year of master in Information Technology at Uppsala University

Lisa does not have much experience of academic writing, something she would like to get before doing her master thesis project next semester. She has never worked in an international project before but she finds that exciting and wishes to work as a project leader or head of a department in a large international company when she graduates from University. She works hard and knows what she wants.