Teaching of Web Design and Programming as a Role-Playing Team Building Game

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***Abstract*—The paper examines a form of training whose aim is to teach technologies for designing and styling responsive web page views and implementing web site events by students in an academic environment. In this form of training a role-play, taken by the practice of a software company is simulated. Data collection and evaluation of the results was carried out through qualitative methods of participant observation, survey, interview, and quantitative comparative analysis. The article analyzes in details the role-playing games, training content, stages of implementation and other aspects of the organization of experimental form of training in Web Design and Web Programming. Teaching, as a simulated role-playing game, is performed during six school hours, in two consecutive weeks and consists of four stages. In the role play, students apply knowledge and teamwork skills in HTML, CSS, JavaScript, jQuery etc. Each team is made up of five students with roles of manager, web designer, graphics designer, web stylist and web developer. The teams' organization is based on work products adaptation of the Rational Unified Process Methodology. The end product of the role-playing game is the development of a website by the team, while its final result for the learning process is the knowledge and skills acquired during formal training by the teacher, and the informal training that took place between the students during their teamwork.**

***Index Terms*—Role play, innovative teaching, web design, web programming**

I. Introduction

According to some researchers in the field of programming education, "Pair programming is more effective than solo programming for Secondary Education" [1]. We look at this issue more broadly and ask the following questions: Is the claim about higher education valid? Can it be argued that programming learning in a small team is more effective? Does teamwork training contribute to the learning of social skills? There are studies in the scientific literature that defend similar theses [2–4]. In the paper, we address these questions during the process of teaching technologies for designing and styling responsive web page layout and implementation of events on web sites by students in academic environment. In recent years, there has been a persistent trend in education to use teamwork methods in class, both in the field of computer science and in other fields [5–7] but in the field of web design and web programming these methods are not well developed.

The focus of the research is the development of a learning method and its application in the disciplines of "Web Design" and "Web Programming" through which to simulate an environment analogous to working in a software company. The simulated environment is the creation of teams of five students who each play the roles of manager, web designer, stylist, graphic designer and programmer. The suggested methodology was applied as an experiment, with the participation of 198 students from the specialties "Software Engineering" and "Software Technologies and Design" in the academic disciplines "Web Design" and "Web Programming". The experiment was conducted at Paisii Hilendarski University of Plovdiv during the academic year 2022/2023.

The main research questions are of two categories: Questions about the quality of teaching in the proposed method, i.e., do the students more efficiently absorb the intended learning material according to the curriculum and questions concerning the building of social skills.

The main objective of the article is to present the concept of the experimental method of learning. The main tasks that are solved with the method are:

- preparation of teaching materials and selection of digital tools;
- creating relationships between students for teamwork;
- study of students' attitudes;
- collecting data and analyzing results.

Data collection and evaluation of the results was carried out through qualitative methods of participant observation, survey, interview, and quantitative comparative analysis.

In point of view of methodology, the discussed teaching process organization is an adaptation of a well-known teaching method "Role-Playing Games" [8, 9]. This method has been further developed and adapted based on the practices of the agile methodology Rational Unified Process (RUP). As a result, a new teamwork learning method was created and implemented in the training of students of the disciplines "Web Design" and "Web Programming". Along with the specialized knowledge laid down in the curriculum, special attention is paid to the acquisition of social skills such as teamwork, dialogic communication, independent research of information, tolerance, taking responsibility, expressing and defending one's own opinion, etc. Many authors support ideas and approaches for implementation of innovative methods of teaching that concern the acquisition of socially significant skills [10–16].

The review of the scientific literature shows that in the field of "Web Design" and "Web Programming" education, such methods are not highly developed.

In Section II the state of the art is examined, in Section III, the prerequisites for conducting the training, in Section IV, a scenario for the implementation of a training method is presented, in Section V, characteristics of the research methodology, and in section six, the discussion and analysis

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of the results.

II. State of the Art

The constituent parts of an experimental learning method are: application of a role-playing game as a physical environment according to the template "roles, activities, and work products" of the agile software methodology Rational Unified Process, the digital tool as an electronic environment and web technology as learning content. At the heart of the training method is the problem of adapting the role-playing game according to the RUP specification for creating work products, which we should consider in detail.

A. Understanding of "Role-Playing Game"

The role-playing game, by itself, is an interactive method, widely used in the study of problematic situations, which are close to the reality as much as practically possible. It is used to prepare the students for the successful performance of various social roles, requiring from them to be "somebody else". It is "a wonderful way for the students to present in a small group their own attitude towards a specific problem with educational purpose" [17]. The role-playing game is based on the understanding of the social roles, representing different forms of behaviour. Through the game, the participants get socialized, because it is necessary to get acquainted with a specific form of behaviour, while at the same time they are required to fulfil the responsibilities assigned and to realize the relevant tasks [18]. The role-playing games are of three main types: simulation games, situational games, dramatization game [17]. Role-playing games go through several main methodological stages in order to be successfully implemented. They are determining the theme of the role-playing game, considering and structuring "plot and scenario", determining the roles that the participants will play in the game, implementing the game and analysing the results. The stages involve activity on both the part of the teacher (who should determine what is required of the students) and on the part of the students (who should do what is required).

A teaching method in the disciplines of "Web Design" and "Web Programming" is developed, on the basis of the above described features of the role-playing games, where the students are divided into teams. The roles in the team are manager, web designer, graphic designer, stylist and programmer. The tasks and responsibilities of the students are distributed based on the practice for organization of software development RUP for the "role-activity-work product" relationships.

B. Understanding of the "Role-Activities-Work Product" Relationship as per RUP

RUP is one of the first agile software development methodologies. The basis of the ideology for the realization of software processes with RUP is the template of interrelationships between roles, activities, work products and workflows [19]. This template represents a static structure of the process or workflows [20]. The template consists of four constituent elements: roles, activities, work products and workflows. A workflow is a sequence of activities that produces a result of observable value [21]. For training purposes, we consider the "roles, activities, and work products", template shown in Fig. 1, without caring at what point the sequence of activities will be implemented. The simplicity of the relationships has made this artefact in a form of teamwork organization in many of the newer and modern software development methodologies. It can be adapted to various business project, but also for training purposes where teamwork, role relationships within the team or between teams exist. According to RUP, roles are a set of competences and responsibilities assigned and performed by development team members. The members involved in the development are called actors or workers. The main roles in RUP are: stakeholder, analyst, architect, developer, tester, project manager and any role. Work products are artefacts, deliverables and outcomes. Activities are the work to be done by the actor of a given role in order to develop or modify the work product, while guidelines are supporting documentation, artefact templates, manuals for application of techniques and practices, examples etc.

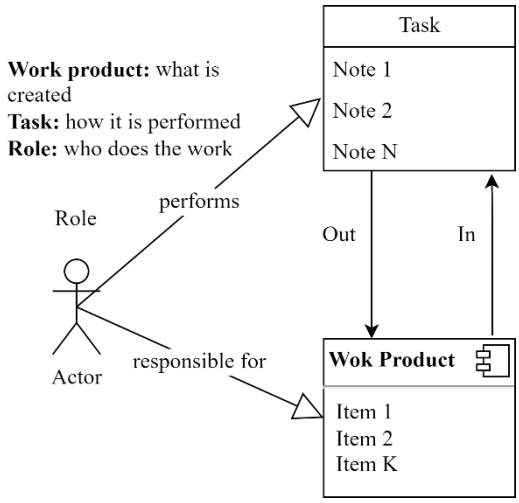

Fig. 1. Relation between roles, work products, tasks and guidance within RUP.

The form of organization discussed is adapted for the purpose of the training of the students. The more significant differences, which distinguish the professional usage of the artefact from its application in the training are that during the experiment at the university, the organization of work is graded at two levels of responsibilities for the students-actors: personal and team; the actors have limited functions due to the specifics of the experiment; there is no requirement for completion of the web site, developed by the team and other peculiarities that exist due to the training character of the role-playing game.

C. Digital Tools in Training

The use of digital tools for the preparation of electronic learning content is a significant part of the learning process [22, 23]. They are highly suitable for storing learning materials in one centralized location, for presenting of additional materials related to the various learning units, for completing homework assignments, and for presenting results of more large-scale interdisciplinary projects [24]. For teachers, they serve as additional means of improvement of motivation for achievement of better outcomes. In the teaching of "Web Design" and "Web Programing", these features of the digital tools have found even more prominent place.

Canva [25] is a web platform, which helps the creation of professional design of leaflets, business cards, greeting cards, presentations, posters, publications for various social networks, logos etc. Thanks to the ready-to-use templates, the creation of the content, required by the user takes very short time and does not require deep specialized knowledge.

In the considered experimental method, Canva is used by two of the team members' work. Part of their tasks include processing of pictures, which to be styled through CSS and media query techniques and practices for responsive behaviour of the web page, taking in consideration the resolution and screen of the user's device, as for example, mobile phone, laptop, desktop computer, television set etc.

Sublime Text [26] is a shareware cross-platform source code editor. It natively supports many markup languages. Users can expand its functionality with plugins, typically community-built and maintained under free-software licenses. The environment Sublime Text is widely used in the courses in "Web Design" and "Web Programing" due to its hardware requirements, opportunities to be used on MacOS, Windows and Linux operational systems and the availability of portable version for Windows.

CodePen [27] is a social development environment for front-end designers and developers. Build and deploy a website, show off your work, build test cases to learn and debug, and find inspiration. The environment is widely used in the courses in web design and programming due to its capability to store and share source code between team participants via cloud technology.

III. Prerequisites for Implementation the Learning Method

It is assumed, that before the initiation of the role-playing game, the students have acquired knowledge and skills in:

1) Basic HTML, HTML Forms, Graphics, Media etc.;
2) Basic CSS, CSS Layout, CSS Grid, CSS Flex box, CSS Responsive, CSS Web Units, CSS Transform and animate etc.;
3) Work with web fonts, work with Font Awesome;
4) Usage of CSS libraries, like animate.css;
5) Bases of JavaScript and jQuery.

IV. Settings for Learning Process Realization and Teaching Method

A. General Framework for Organization of the Teaching Process by the "Role-Playing Games" Method

Despite of the fact that the various role-playing games differ, depending on the subject, learning content, didactic materials, target group, location etc., they share some common parameters. The most important characteristics of the role-playing game are: role situation, role play plot and organizational instructions, participants and actors, provision of a subject and determination of teams, guidance on the performance of the typical role, scenarios of the roles of the actors, analysis of the results of the game and the performance of the roles etc. Table I presents more details on the parameters applied to the role-playing game, adapted for the courses in "Web Design" and "Web Programming".

TABLE I: Role-Playing Game Characteristics, Adapted for the Course in "Web Design" and "Web Programming"

FEATURES	DESCRIPTION
Role situation, plot and organizational instructions	The purpose of the training is to put the students in conditions of non-traditional conducting of classes, close to a real situation, practicing teamwork skills. For this purpose, the requirements for students, roles, tasks and responsibilities, requirements for product development, criteria for differentiated assessment of team participants, selection of individual topics for individual teams, etc. are determined.
Participants and actors, taking a specific role	The acting persons are the students, who have functions of an actor for a given role. The participants in the game, who have indirect relation to the training, may be outsiders, tasked with observation, reporters of the observation, mentors etc.
Setting of a subject and distribution of teams	The teacher provides an assignment with common subject, by clarifying the specific tasks of the participants and the teams. Each team consists of five actors with different roles.
Performance of the typical role	The typical roles for the student actors are manager, web designer, web stylist, graphics designer and programmer.
Typical scenarios for the roles	The teacher, as a mentor of the role-playing game, should provide short instructions about the conditions, assignment, team, rules of work, like: - provision of short, precise and well formulated assignments; - determination of simple rules; - requirement of active involvement of each of the students; - guidance for work regarding the didactic material, prepared in advance, including technical means; - determination of a time frame, when the experiment is spread over several school hours.
Determination, modelling and documentation of roles, which will be performed by the game participants	The teacher provides report-forms, in electronic format, organized as tables with participants, tables with roles distribution in the team, sample of list of tasks and responsibilities of the team members, sample of list with indicators for particular situations and opinions, list with tasks assigned and resolved etc.
Game realization	Students perform their roles according to the specified requirements. It is allowed, during the plot development, two or more students to switch roles, when there are circumstances compensating for a given inability, for example, for solving a specified task.
Analysis of results	Qualitative and quantitative methods are applied to analyse the results. An analysis stage takes place after the experiment is completed. Qualitative analysis is carried out on the basis of minutes of discussions during the development and during its presentation. Quantitative analysis is applied as a comparison between educational evaluations from the previous and current academic year.

B. Stages of Implementation

Conditionally, the role-playing game is divided into four stages, organized in two school weeks with three school hours per week. During the first stage, the teacher, as the mentor of the game, announces the general subjects, divides the students into teams and provides a private subject to each team. The teacher is also a leader of the general discussion. At this stage, organizational matters for the experiment itself and technical issues related to the educational content are discussed. The duration of the stage is 45 minutes. During the

second stage, the team distributes its responsibilities and tasks according to the roles of the actors. The team discusses the approach, which will be used for the realization of the development. The duration of the stage is 45 minutes. During the third stage, the goal of the teams is to establish main approaches for realization of the individual components of a web page. The duration of this stage is also 45 minutes. This stage marks the end of the first part of the role-playing game. The fourth stage of the role-playing game takes place during the second week and its duration is 135 minutes. This part is a workshop for the teams.

C. Plot and Scenario of the Realization of a Role-Playing Game for Experimental Purposes of Training in the Courses "Web Design" and "Web Programming"

The subject of the experimental role play is "Application of design techniques, styling of adaptive and responsive layouts and development of a functioning web site". The provided educational content for the role-playing game is part of the curriculum for the courses "Web Design" of specialty "Software Technologies and Design" and "Web Programming" of the specialty "Software Engineering" at the Faculty of Mathematics and Informatics of Paisii Hilendarski University of Plovdiv. Despite of the specific disciplines, the role-playing game with the above subject can be successfully applied in various training courses for beginners and advanced web designers, graphic designers and web programmers, with appropriate selection of educational content. For the specific subject discussed, students are required to design a web page layout using HTML, style the page using CSS, use the libraries Google Fonts, Font awesome, Animate.css etc., develop adaptive and responsive layouts using established practices for work with adaptive units of measurement, the CSS Grid or CSS Flex Box approaches and the media query technology, to process appropriate graphic images for background using the Canva web platform, to program a functional module using JavaScript or the jQuery library. The work environment is Sublime Text or CodePen.

Each team will be assigned with the so-called private subject. This subject is related to the development of web sites types, which are preliminary determined as subjects. They are: personal web site; corporative web site; informative web site of a state body; blog-type web site; virtual gallery type web site; media type web site; e-commerce web site etc. Special attention in the development of the plot of the role-playing game deserves the development of a work product according to the "roles, activities and work products" template. To facilitate the students' work, some sample tasks have been defined to assist them in defining "activities" and creating "work products".

The teamwork, starting with role distribution, assignment and performance of tasks, up to the development of the ready web page, are documented and reported in tables and lists. The responsibility for documentation and reporting belongs to the actor, performing the role of the team manager. Sample tables and lists for documentation of the work are: Table II: Team members, Tables III: Roles distribution in the team, List with tasks assigned, Table for task assignment etc. The purpose of these reports is to document the work both at team level and at individual actor level. These reports will be used for assessment of the individual work of each student.

TABLE II: TEAM MEMBERS

Participant	Name	Specialty	Course of study
P1			
P2			
P3			
P4			
P5			

TABLE III: ROLES DISTRIBUTION IN A TEAM

Role	Actor
Manager	
Web designer	
Stylist	
Graphics designer	
Programmer	

V. FEATURES OF RESEARCH METHODOLOGY

Qualitative research is characterized by a strong individuality of the researched object and a narrowly expressed specificity of the researched subject. For this reason, they are often one-off and created specifically for a specific study. In the present study, the qualitative methods of participant observation, surveying, interviewing, comparative analysis of theoretical data and quantitative comparison of educational assessments in two consecutive academic years were applied. In the comparative analysis, a combined approach of qualitative and quantitative methodology was used. The main approach to data collection is participant observation, where the researcher is the so-called "participant observer", i.e., he/she "gets closer" to the investigated persons and processes by directly participating in them. For the purpose of the study, a variant of participant observation was developed, and more specifically, the simultaneous participation of two observing teachers. One teacher leads the class and has the classic role of participant observer, while the other performs the function of observing researcher. When conducting the experiment, due to the presence of two teachers, a participating observer and an observing researcher, the obtained information is of a greater degree of objectivity, and the effectiveness of observation is higher. The diagnostic methods are applied in accordance with the concept of conducting qualitative research in the field of software technology training methodology, the main principles of which state that: "When conducting qualitative research, the researcher must be "in the field", close to the natural work environment of the researched persons and in active interaction with them as a participating observer"; "During the conduct of qualitative pedagogical research, there is a dialectic between available and currently received information" [28, 29]. The mentioned concept represents an author's approach to the application of qualitative research methods. It is a refinement and adaptation of Grounded Theory [30].

The main parameters of the diagnosis of the training method are:

Object of research: The adaptation of a role-playing game according to the template "roles, activities and work products";

Subject of research: The acquisition of social skills through the "adapted role-playing" training method in the

academic disciplines "Web Design" and "Web Programming";

Purpose: Study of the assimilation of specialized and social knowledge, skills and competences when conducting an experimental teaching method.

Enrolment: 198 students;

Methods: Participatory observation, survey, interview, comparative analysis;

Results: Theoretical analysis, conclusions, statements.

VI. Discussion and Analysis of Results

The examined method of organization and teaching was implemented with 198 students from two different courses. The training was conducted in groups of 20 students. Each group formed 4 teams of 5 students. The total number of investigated teams is 38, and 8 of the students did not participate in the formation of a team.

The comparative analysis of educational grades obtained by students in two consecutive academic years in the disciplines "Web Design" and "Web Programming" is presented in Table IV.

TABLE IV: Average Grade

	Discipline	Average grade
2021/2022	Web Design	5.34
2022/2023	Web Design	5.42
2021/2022	Web Programming	4.89
2021/2023	Web Programming	4.96

Table IV shows that the educational evaluations in the disciplines in the two consecutive years vary within small limits. This shows that the specialized knowledge and skills for applying web technologies do not differ significantly in traditional training and in the adapted role-playing game based on the "roles, activities and work products" model. A significant difference, however, is the acquisition of social skills. In this sense, we can conclude that: adapted role-playing is superior to traditional learning because it has the potential to teach specialized technologies and social skills.

During the fourth stage of the experiment, the observing teacher takes notes with opinions, thoughts, ideas, etc. At the end of the class, a short interview is held between the two teachers - the one leading the experiment and the observer, and so-called qualitative coding of the collected data is carried out. A separate source of data is the student survey. The survey card contained two types of questions - choice of answer and written argumentation. It is interesting to note that when studying in the two consecutive academic years, the quality of their software developments is in favour of the method under consideration. Such a statement can easily be explained by the fact that in the academic year 2021/2022 students independently develop a website according to certain requirements, while in the academic year 2022/2023 a team of five students develops a website. However, this aspect is not the subject of research. It is important for the research to extract characteristics of acquired social skills from the students. Such data were obtained from interviews and questionnaires. The most important results are summarized in the answers to the questions: 1) "Which learning method do you prefer?" and 2) "Did you learn new social skills in learning through adapted role play?" The results of questions 1 and 2 are summarized in Table V and Table VI.

TABLE V: Which Learning Method Do You Prefer?

Traditional education	12%
Roleplaying Adaptation	72%
I can't say	16%

TABLE VI: Did You Learn New Social Skills in Learning through Adapted Role Play

Yes	27%
Rather "Yes"	35%
Rather "No":	17%
I have not acquired new social skills	21%

It is interesting to note that to the question: "List what social skills have you learned?", students respond with a variety of different answers. The more common answers can be summarized as: Increasing communication in critical situations, working in a team in the condition of solving unknown problems, showing patience, tolerance and a positive attitude caused by the desire for the success of the team, empathy towards other members of the team, teamwork planning skills, etc.

In the course of debriefing the teams, during the general discussion after the submission of their works, pre-formulated questions are asked, such as: "What motivates you to find a solution to a problem you do not know?", "How did you make a choice for software practice application?", "Were the solutions you found studied in previous lectures and exercises?", and others. Although a numerical quantitative assessment cannot be made, due to the qualitative analysis of the collected data, a definite conclusion must be made that: the interest in the discipline when working in a team is significantly higher than the independent preparation of course projects.

The conclusions of the teachers who conducted and observed the research are that the students' interest in the role-playing game is generated by the opportunities for teamwork, under conditions of clearly written organizational rules, theoretical concepts and applied technologies. It is important to note that the majority of students united around the opinion that this concept should be studied in the educational content.

VII. Conclusion

When conducting the experiment, it is necessary that the students have well mastered specific concepts and technologies. For this reason, it is held in the last six academic hours. As you might expect, the complexity of technology has a direct impact on student productivity. This did not appear to be a significant hindrance to students' coursework productivity.

The aim of the article to present the organization of training as a "role play", discussing the manner, the conditions, the teaching methods and the means of application, has been achieved. Through the studied method of study, students are stimulated to improve and further develop their work beyond the initially foreseen requirements,

which in itself means that they acquire knowledge and skills exceeding what is intended for learning by the curriculum. Regarding the second category of research questions concerning the acquisition of social skills, the analysis of the experiment shows that the adapted role-playing game is superior to the traditional training because it has the potential to teach social skills, such as increasing communication in critical situations, teamwork under the condition of resolving unfamiliar problems, showing patience, tolerance and a positive attitude caused by the desire for team success, empathy for other team members, teamwork planning skills, etc.

This training method is closer to a future real work environment. For this reason, its successful integration is significant for the learning process.

Future work on the topic is related to a thorough analysis of the acquired knowledge in the field of web technologies and teamwork skills, as a result of which the formalization of the considered training as a method of the curriculum and practice should be sought. From this point of view, the role-playing game adapted according to the "roles, activities and work products" template reveals a new educational perspective.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

I.V. conducted the research and wrote methodical aspects of the paper. H.H. analysed educational practice and wrote theoretical aspects of the paper; All authors had approved the final version.

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