GitHub as backbone in Software Engineering course: Technology acceptance analysis

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Abstract - In the field of software engineering education, continuous adjustment of course content and technologies with real-working environment is crucial for developing students’ skills that meet the needs of the labor market. The main goal of this paper is to present the research result regarding the use of GitHub in Software Engineering course which has characteristics of real-working environment: students are divided into up-to-five-member teams with adequate development roles and during the semester are working on project which encompasses full software development life-cycle. A pilot study was conducted in the end of the summer semester of academic year 2017/2018 on the sample of undergraduate students (N=78) whose study field is related to informatics. New measuring instrument was developed and consisted of scales related to the UTAUT (Unified Theory of Acceptance and Use of Technology) model, but also those related to learning value, learning satisfaction and ease of use to investigate in detail students’ acceptance of GitHub in context of software engineering learning. Results of the study outlined following remarks: students find GitHub useful in team coding projects, its ease of use has positive effect on students’ acceptance, as well as on learning satisfaction and learning value of software engineering in practice.

Key words - GitHub, UTAUT, software engineering, technology acceptance

I. INTRODUCTION

As Information and Communication Technology (ICT) is inevitable part of modern education, concept of online social learning is intensively (re)shaping future ways of teaching and acquiring knowledge in Software Engineering courses. In this concept of social learning, peers (students) simultaneously consume and generate course content on different levels of interactions: peer-to-peer, student-to-instructor [1], but also connect with wider programming community using online collaborative social platforms as GitHub, social networks, YouTube channels, MOOCs [2] or Q&A sites like Stack Overflow [3]. In Software Engineering work environment, but also educational settings on universities, GitHub is one of the most popular social coding platforms which allows users (in this study: students) to keep tracking of their code, its versions and changes and to easily collaborate on open source software projects and activities. Microsoft’s acquisition of GitHub in June of 2018 was a point-blank sign for 28 million of developers using platform that this giant wants to empower IT professional community throughout learning, sharing and working together to create software [4].

In educational context of Software Engineering, advantages of using GitHub (or similar version control and social coding platforms like BitBucket) are on the both sides involved: teachers use platform for course materials distribution, collecting project-coding assignments and creating collaborative environment for students’ teams [5].

Both, theory and practice point out that GitHub as a collaborative and version control tool should be introduced in education process as it brings different benefits to the students such as transparency in learning and peer learning, access to technology, direct feedback and self-promotion [6], easy coordination and less work downtime [7], easy contribution to existing open-source projects that help to form personal opinion on their technological, quality or other aspects [8], it increased the number of interactions [9] and it is de-fact standard used in industry projects.

From students’ perspective, most important GitHub’s benefits are: transparency which allows learning from others and continuous monitoring other team members activities in every development phase, motivation in competitive educational context [10], access to technical knowledge, developer self-promotion [6], but also bridge to real-working environment (e.g. job ads listing GitHub experience as demanding technical skill for IT, or using GitHub as professional portfolio when applying for open positions) [5].

Even though GitHub is not a pioneering technology in education, still students are mostly unfamiliar with it due to instructors’ lack of awareness of its benefits and relevance in real-working environment. In IT sector, social collaboration is important because it implies working with others to achieve a common goal, and consequently social worker is skillful in using such tools to manage job-related tasks and projects [11].

Technology acceptance models like UTAUT (Unified Theory of Acceptance and Use of Technology) or TAM (Technology Acceptance Model) are widely used to expand the understanding of technology actual usage and acceptance. Yet, GitHub’s acceptance by students - its actual role/potential in the field of Software Engineering education and technical skills development - is still new and unknown research area.

UTAUT constructs regarding the usage and acceptance of technology are facilitating conditions, performance
expectancy, effort expectancy, social influence and behavioral intention [12]. Model has been used in various researches in educational contexts: e-learning, mobile learning, video lecturing etc.

Authors [13] stress that understanding of factors that are crucial for implementation of new instructional technologies in education should be looked thorough social influence, one of the constructs of UTAUT model. Among students, technology adoption is strongly influenced by peers and their opinions. Since GitHub is a collaborative social coding platform, social influence is relevant on different levels: peer-to-peer, teacher-to-student and wider developer community in general due to GitHub’s transparency and opinions for self-promotion, communication and learning from others. Positive perception of social influence by peers positively relates to students’ behavioral intention to use technology. UTAUT model was used in assessment of students’ behavioral intention to use desktop video conferencing in distance course, but autonomy variable was added to extend the model and improve the predictive value of model. Results of this empirical study show [14] that students’ behavioral intention to use such technology is driven by their expectations that outcomes of its use will help them in acquiring knowledge (academic performance in general), their peers and faculty members believe they should use it. Yet, technical problems that could interrupt students’ learning should be resolved quickly.

Results of study [15] focused on LMS (learning management system) use examined UTAUT model extended with learning value show similar conclusions: students’ intention to use LMS is positively related to their perception of its usefulness for academic activities. Moreover, in settings where use of technology is mandatory, students’ intention to use LMS is influenced by teachers’ and colleagues’ explication of its benefits so social influence is crucial in every technology adoption process.

An extended UTAUT2 model suggested by [16] to examine acceptance software engineering tools in academic education. In this study students’ acceptance of CASE tool used for IS modeling and supporting Agile practices was examined. Behavioral intention was mostly explained with performance expectancy which was strongly influenced by two independent variables from UTAUT2 model: effort expectancy and social influence. Taking into consideration new variables extending UTAUT2 model, Model Interchange variable had the greatest impact on students’ intention to use CASE tool. Items related to assessment of this variable included tool’s features as exporting and importing diagrams and models, integration of developed documentation with other tools, and implementation of project in different tool versions and editions with regard to backward.

From the results of motioned studies, it can be concluded that performance expectancy and behavioral intention are positively related in context of students’ acceptance of technology in educational settings. Regardless different context of technology use, UTAUT model can be used as baseline for determine students’ acceptance and use of technology in Software Engineering education, but also additional variables should be added to explain more precisely predictors for collaborative platforms like GitHub. Researches constantly attempt to expand the model to find other determinants to predict variance in dependent variable, which in case of UTAUT is behavioral intention to use some technology. In this pilot study additional variables were included to go beyond original UTAUT model. Basis was extensive literature review in which collaborative social coding platforms were taken from the students’ perspective. Therefore, learning value, learning satisfaction and perceived ease of use of technology were included. Variables are explained in Measuring instrument section.

II. METHODOLOGY

A. Context of the study

As a part of a continuous improvement of course content and teaching methodology we introduced the use of GitHub in our course on Software Engineering more than five years ago. The course is performed in the last semester of the bachelor’s degree study program and it builds on the previously acquired knowledge in programming, object-oriented paradigm, database management and administration, business process modeling, user interface design and project management. However, the students had no prior knowledge on the use of GitHub in programming.

The course activities, which were finished before the study was performed had the goal of introducing the students with the theory and practice of software engineering and as such included the lectures and case-studies related to the use of GitHub and possible workflows, preparation and defense of laboratory exercises on the use of GitHub in practice and continuous work on practical assignment - project. While working on projects, students have been divided into up-to-five-member teams, were given a mentor who closely monitored, guided, feedbacked and finally evaluated their activities. Projects included the performance of full-scale software development life-cycle including the activities of user requirement analysis and specification, design, development, testing, deployment and documentation of software product. For the first time during their bachelor’s education students have performed such complex project.

Such educational setting offers students the insight into a real working environment where they will have to solve complex software engineering problems by leaning on team work, collaboration and direct feedback. Back-to-back with other important technologies, collaborative and version control platforms like GitHub also represent a base for implementation of highly popular DevOps practices like continuous integration, testing and deployment which

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brings additional learning value and hopefully increases a learning satisfaction of students.

B. Problem and research goals

To fulfill discovered literature and research gap on using GitHub for specific Software Engineering learning and teaching activities, main goal of this case study analysis was to disclose if additional variables (learning satisfaction, learning value, perceived ease of use) can be integrated with UTAUT model as predictors of students' intention towards GitHub use in software development activities. UTAUT is very robust model and can explain up to 70% of variance in dependent, but appropriateness of new measuring instrument should be taken into consideration [16].

C. Respondents

Respondents in the study were undergraduate students (N=78) from one Croatian university who took the Software Engineering course. The majority or students (94.94%) were full time students, mostly aged from 21 to 23 years, while 7.62% were aged from 24 to 26. By gender, 60 male and 18 female students participated in this study.

D. Measuring instrument

Research was conducted by Google Forms online survey in the end of the summer semester after students finished their course and project activities. Participation in research was completely voluntary and anonymous. The findings of the research in this paper represent a more detailed analysis of the data from pilot study which was conducted in the 2017/2018 academic year. The results of first part of the research devoted to UTAUT model and collaborative learning were presented on another conference [17]. After a literature review, a new measuring instrument adjusted to GitHub context was built upon variables related to: (a) UTAUT model (facilitating conditions, performance expectancy, effort expectancy, social influence and behavioral intention) (b) learning value; (c) learning satisfaction and (d) perceived ease of use of technology. UTAUT constructs were adapted to GitHub context from more general research and tested measuring instrument for the Acceptance of Software Engineering Tools in Academic Education [16]. Survey included socio-demographic questions and five-point Likert-type scale was used as attitude and opinion measure. Since UTAUT constructs included in study were described in detail in previous report, in this paper focus will be given on learning value, learning satisfaction and ease of use of technology. It is important to stress that all of the items in study were related to GitHub and students experience with using it for project activities. Students were not questioned about overall course satisfaction – focus was on GitHub which was clearly stated in purpose of study. Furthermore, in each item keyword GitHub was mentioned so students could easily assess their opinions upon this platform.

Learning value construct was adapted from study [15] where authors assumed that learning value influences the behavioral intention to use LMS. For this research, items were adjusted for GitHub context (e.g. “Learning through program assignments / projects in GitHub is worth more than the time and effort I have invested in this activity.”) and construct consisted of four items.

Learning value from students’ perspective refers to benefits gained from time and effort invested in learning and working on projects in particular environment. Comparing learning value to Venkatesh et al.’s (2012) price value definition, authors stress that if students’ investment time and effort has positive learning value, students will have positive attitude for using technology [15][18].

Learning satisfaction was often questioned in previous computer-mediated learning studies from the standpoint for users’ acceptance of technology and to determine students’ attitude towards technology. Learning satisfaction construct consisted of five items (e.g. “I am satisfied with my learning activities using GitHub.”) and were adapted to GitHub context from study [19].

Interesting aspect related to GitHub is peer-to-peer learning that in online environment leads to greater students’ satisfaction [20] but still, positive learning environment is important. Students’ satisfaction drivers are effective peer-to-peer interactions and student-to-instructor interactions that improve learning climate in online context [21].

Perceived ease of use of technology construct numbered six items (e.g. “I make no mistakes using GitHub.”) which were adopted and adapted from original Davis’s TAM (Technology Acceptance Model) research to specific GitHub context. Perceived ease of use refers to ones’ belief that using technology will be effortless. Since this construct is not part of original UTAUT model, it was included in research because Davis suggests that the ease of use of technology affects users’ intention to use it [22].

Reliability of constructs included for analysis in this study were examined using Cronbach’s alpha coefficient. This step in necessary because items in questionnaire were adapted from other studies and adjusted to specific GitHub context. It is crucial to determine whether for some constructs additional items should be included or excluded for future versions of measuring instrument.

It is important to note that internal consistency of UTAUT constructs was analyzed and reported in our previous study. In the case of Learning satisfaction (α=0.806) and Perceived ease of use (α=0.851) Cronbach’s alpha coefficient values were higher than the suggested benchmark value of 0.70 [21]. Cronbach alpha value for Learning value construct (α=0.640) was below 0.7 which reveals that additional items should be included in future research.

III. RESULTS AND INTERPRETATION

A. Regression analysis

For data and statistical analysis IBM SPSS Statistic 23 was used. Regression analysis was conducted to reveal how dependent variable – behavioral intention of students using GitHub can be explained remaining variables from
The UTAUT model with additional ones included in study: learning satisfaction, learning value and perceived ease of use. Calculated multiple correlation coefficient (R) for behavioral intention was R=0.778 indicating a good level of prediction. Regression model is shown in Table I. The coefficient of determination (R²=0.606) indicates that 60.6% (R²=0.606) variability of dependent variable (behavioral intention) can be explained with independent variables included in study.

<table>
<thead>
<tr>
<th>Table I.</th>
<th>Model Summary - Behavioral intention (N=78)</th>
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<td>Model</td>
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<td>1</td>
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a. Predictors: (Constant), Facilitating conditions, Performance expectancy, Effort expectancy, Social influence, Learning value, Learning satisfaction, Perceived ease of use.

To determine which variables can be used as predictors for students’ behavioral intention, from further analysis can be concluded that Perceived ease of use (p=0.003) and Learning satisfaction (p=0.034) are statistically significant variables that can be used for predicting students’ intention towards the use of GitHub. In case of other variables included in the study, p>0.05 so they cannot be considered as predictors of dependent variable behavioral intention (see Table II). From the proposed model, behavioral intention varies on two independent variables as follows: behavioral intention = 0.932 + (0.139*perceived ease of use) + (0.228*learning satisfaction).

<table>
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<tr>
<th>Table II.</th>
<th>Statistical Significance of independent variables and estimated model coefficients * (N=78)</th>
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<tr>
<td>Model</td>
<td>Unstandardized Coefficients</td>
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<tr>
<td>Constant</td>
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<tr>
<td>Facilitating conditions</td>
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<tr>
<td>Performance expectancy</td>
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<tr>
<td>Social influence</td>
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<td>Effort expectancy</td>
<td>-.100</td>
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<tr>
<td>Perceived ease of use</td>
<td>.139</td>
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<tr>
<td>Learning value</td>
<td>.308</td>
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<td>Learning satisfaction</td>
<td>.228</td>
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</table>

A. Dependent Variable: Behavioral intention

B. Discussion

Results of this study reveal that variables from UTAUT model (Facilitating conditions, Performance expectancy, Effort expectancy, Social influence) are not statistically significant predictors for variance of dependent variable – behavioral intention of students to use GitHub for academic purposes if in regression analysis additional variables are included.

On the other hand, perceived ease of use and learning satisfaction proved to be as predictors for students’ behavioral intention, and regression model in general explains 60.6% of variability of dependent variable (behavioral intention) with independent variables.

Even though perceived ease of use and learning satisfaction revealed as statistically important and their internal consistency is good, comparing the results of our previous study on the same data set opens several questions that should be discussed. Results of our previous study, where only UTAUT model variables were included in regression analysis, performance expectancy and social influence revealed to be statistically significant variables that can be used as predictors for behavioral intention [17]. Adding independent variables that seemed relevant from literature, changed the predictors of variability of behavioral intention. Also, results of regression analysis of this study explained 60.6% variability of the dependent variable (scores of the Behavioral Intention Scale) in the regression model and in previous (UTAUT-only) score was 50.4%.

In the context of the results examined in this and previous studies, some changes in measuring instrument and research model should be done. The main reasons that may be cause are complex learning, yet social collaboration environment, different technologies students use in classrooms, but also their motivation.

IV. Conclusion

From the results of this pilot study in which UTAUT was used as backbone to reveal students’ acceptance of GitHub, several conclusions revealed:

- variables outside UTAUT model may have an important role in understanding students’ actual intention to use social coding platforms. In our study perceived ease of use from TAM and learning satisfaction turn out to be statistically relevant;
- measuring instrument should be improved throughout interviews with students to determine what is important in academic settings and GitHub adoption;
sample from pilot study is very homogenous and new developed measuring instrument should be tested and checked in other environments (for example - other university).

Analysis from pilot study so far only clarify how complex the learning environment in Software Engineering is from students’ perspective, but also instructor’s role, especially setting up course environment should be included in future study.

As far as future work is concerned, great challenge may be number of Software engineering courses where GitHub is used in similar work-imitation academic settings where instructor is focused on students’ learning satisfaction, learning value and peer-to-peer learning.

Other limitations arise from purposive sampling – this study included point of view of students from one course so results cannot be generalized. Since the purpose of pilot study was to determine if chosen variables were adequate for extending the UTAUT model for exploring predictors of student’s acceptance of GitHub in more mature phase of research the range of generalization of the results will be widened. In this study another part of results from pilot study was analyzed and in future research with new and validated measuring instrument gathered data will be applicable for generalization and comparison with similar researches in IT educational context of using software development supporting technologies.

REFERENCES


