

# Students Creative Workshop as a Platform for the Formation of Entrepreneurial Skills in Engineering Education

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**Abstract.** The paper discusses the issues of sources, methods, and conditions of the formation of students' skills in the vocational training led to the entrepreneurial behavior of graduates. It is based on the work of the students' creative workshop "Geo-S" within engineering geodesy university course. We proposed that the formation of entrepreneurial skills carry out as part of entrepreneurial self-efficacy development with deferred entrepreneurial intentions. Experimental part included pilot surveys, case study method through in-depth interviews with workshops' members, and self-assessment survey to determine the significant events of the workshop. We constructed the model of skills formatting for entrepreneurial behavior of future engineers within students' creative workshop based on vocational training courses where the next components for entrepreneurial self-efficacy are most crucial: proactiveness, competitiveness, learning orientation, teamwork, product development, leadership, creativity.

## 1. Introduction

Entrepreneurial activity of youth is one of directions of the development of contemporary civilization. One of the key competences for life-long learning is the "sense of initiative and entrepreneurship" in European educational space [1]. In various world regions entrepreneurship training in universities serve promotion entrepreneurship among youths for creating ventures and jobs and leads to growing national and regional economics [2-5]. Evidently that educational organizations of vocational training must take into account the objective cultural and historical differences of their students. In Russia experience of entrepreneurship does not cover several successive generations, and the existing system of professional education often do not correlate with the practical activities – so specialists cannot realize their potential by best ways [5]. The Russian government actively proposes ways to solve the problem of developing modern skills of specialists, including innovative entrepreneurial activity with a significant increase in labor productivity (according Strategy of Innovative Development of the Russian Federation for the Period up to 2020 and other Federal strategic documents).

It is worth noting that in the current conditions of an unstable long-life career and poly-professional mobility, entrepreneurial skills become the accelerator of not only economic but also personal and macro-social positive changes [6, 7]. Previous studies of personal entrepreneurial characteristics show

that engaging employees in intrapreneurship plays an important role in organizations [8]. Therefore, the formation of entrepreneurial thinking and behavior among youth is in demand and possible not only within business education. The alternative should be an education system aimed at entrepreneurial competences training for all branches of vocational education [2, 9]. Technical education is no exception, the formation of entrepreneurial thinking and behavior of future engineers are considered as a relevant problem [3, 4]. In particular, article [10] describes the experience of effective entrepreneurial training at university of architecture and civil engineering (in Kazan, Russia) on a platform of scientific-educational cluster.

Since entrepreneurial skills are based on a common base of social skills and relationships, their formation can be carried out using well-known technologies such as problem-based learning, project-based learning with team-work [11]. The ways and events to reach entrepreneurial skills are closely related to training with learning-by-doing methods and engagement of students. Among them may be internships, attending business fairs and expositions, attending business seminars, courses with introducing innovative learning methods, and some others [12]. Such training is possible within the framework of vocational disciplines of students [13]. The advantages are that it is closest to the professional sphere and problem-oriented to it. In our article, we consider the issues of formatting of skills for entrepreneurial behavior of future engineers with students' creative workshop at university of architecture and civil engineering (in Novosibirsk, Russia) where student teams carry out projects to develop unique electronic educational resources while studying the course of engineering geodesy.

## **2. Research in entrepreneurship in vocational training**

Most often, the goal of entrepreneurial training in the training of non-business students is to achieve not high but some sufficient level of entrepreneurial competence [7, 11], to form the necessary qualities of students, and to demonstrate entrepreneurial thinking and behavior by them. For problem-oriented professional disciplines, they talk about non-cognitive components, skills and attitudes first of all [11]. Entrepreneurial competencies are "knowledge, skills and attitudes that affect the willingness and ability to perform the entrepreneurial job of new value creation" [11, p. 12]. Non-cognitive competencies have very significant value for professional and social activities but they are difficult to form and evaluate [11]. Among such skills not directly connected with the business knowledge, they can note resource, opportunity, interpersonal, learning, strategic ones [14]. Samples of possible key measures are opportunity recognition, openness to experience, critical thinking [12], self-efficacy, entrepreneurial passion [14], proactiveness, uncertainty [15], and many others [11]. Personal entrepreneurial qualities may include also integrity, credibility, intelligence, presence of imagination, ability to make decision, ability to organize control, to provide justification of decisions [10].

At all, quite a lot of diverse papers are presented in the field of the study. Among recent studies, a review of the literature on entrepreneurial self-efficacy (ESE) [16] was valuable for our research. It is devoted to the structure, measurements, and relationships of ESE with other characteristics, in particular, with entrepreneurial intentions (EI) and perceived desirability of engaging in entrepreneurship (PDEE). EI defines "the intention of an individual to start a new business" [1, p. 20]. It is important that the review postulates that the issues of team-working, which our paper touch upon in the analysis, remain poorly researched [16]. Secondly, the decisive importance of ESE receives a deep theoretical justification. Thirdly, EI is indicated as a goal in the formation of ESE, as it has the greatest impact on the effectiveness of the entrepreneurial behavior of graduates. It can be also significant to combine EI and entrepreneurial orientation for commercialization in educational organizations of vocational training [17]. A number of researchers in engineering education note that students of technical universities initially have little business intention [3]. This fact is reinforced by the peculiarity of the youth labor market in Russia with the growth of poorly sought-after graduates of "economic" specialties with a general low entrepreneurial activity of youth [9]. Therefore, the issues of determining the sources, methods, conditions, and limitations of the formation of problem-oriented skills in the professional training of students, which subsequently lead to the entrepreneurial behavior of graduates, are of high importance for Russian and international engineering education.

### **3. Statement of the problem**

This research is a response to one of the experimental branches of a broader study in the field of professional engineering training on the platform of the students' creative workshop "Geo-S" of Department of Engineering Geodesy NSUASE (Sibstrin) [18, 19]. Volunteer workshop participants are separated students from the general stream of the second year's students who study engineering geodesy as a general professional discipline. Comparison of interviews of two samples of students who took (n=20) and did not take part (n=22) in the workshop did not show differences in the contradictory attitude towards entrepreneurship and a rather low desire to participate in such activities in the future. Feedback from both samples included neutral, positive, and negative comments. This, in general, is consistent with the data of other researchers in engineering education [3].

Meanwhile, the results of the official survey of two samples of graduates convincingly demonstrated the difference in the entrepreneurial behavior of the graduates who participated in the work of creative workshop and the random sample of the remaining graduates – 42 respondents totally [18]. So, 85% of the workshop's graduates showed high entrepreneurial activity, there is no negative attitude to entrepreneurial activity was revealed while interviewing the remaining 15% of the successfully employed workshop's graduates: they allow such participation in the future. Among another sample of young graduates, the fraction of entrepreneurs does not exceed the regional average value 5%, and the sum fraction of employment by profession is 78%. We emphasize that this is not a research comparison of the levels of entrepreneurial competencies. Objective data from the monitoring services of NSUASE (Sibstrin) demonstrate a highly successful involvement in the entrepreneurial activity of creative workshop graduates both related to professional activity and not related to it. This contradiction led to the statement of the problem: which possible sources, methods or conditions of the formation of professional skills of students within students' creative workshop subsequently led to the entrepreneurial behavior of graduates.

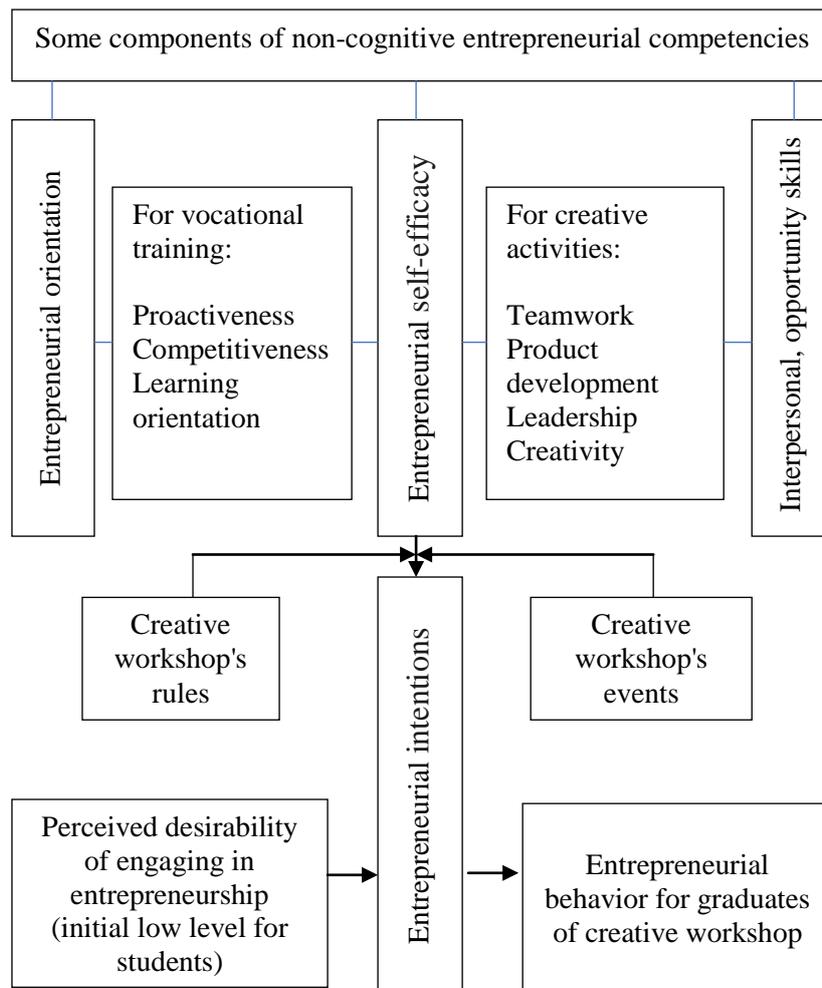
### **4. Background and research methodology**

To find possible solutions to the research problem, we first conducted an analysis of related papers. Entrepreneurial intentions, which play a crucial role in the implementation of entrepreneurial behavior are multicomponent, and leading components include attitude towards entrepreneurship [3]. But we found research showing that even with low perceived desirability of entrepreneurship, individuals can develop entrepreneurial intentions (EI) to act in an entrepreneurial way when they feel capable of performing such actions while possessing sufficient levels of entrepreneurial self-efficacy (ESE) [20]. ESE is highly relevant for such factors of entrepreneurship as risk-taking, uncertainty, creativity, leadership, proactivity, persistence, and passion [16]. Some studies emphasize the close relationship of ESE with general self-efficacy ("a global belief about one's capabilities to solve future tasks of any kind" [16, pp. 3-4]), at least in vocational training [1]. In this case proactiveness, competitiveness and learning orientation were significant predictors of self-efficacy that was experimentally confirmed in a study of students' entrepreneurial orientation [1, p.6]. Entrepreneurial orientation in combination with sufficient level of entrepreneurial intentions may additionally contribute to the practical commercialization and educational products development, as already noted above [17]. We have suggested that the formation of some entrepreneurial skills of students within creative workshop "Geo-S» carry out as part of ESE development with deferred EI of graduates. So, we need to understand which established rules of the creative workshop "Geo-S" and the events held by the head are consistent with the considered background.

Let's briefly describe the work of the students' creative workshop "Geo-S". Lecturer of engineering geodesy as the head of the creative workshop directs the work of several students' teams with selected leaders. The goal of each team is the creative design of electronic educational products with a professional focus [19]. Students themselves conduct research on content selection, offer design and choose development tools. After completing the current project, educational products undergo internal defense and are used in the engineering geodesy course, and then are actively represented at different competitions and conferences. Further, participants can start working on another project in the same or

a new team or develop a ready-made educational product participating in the workshop several years before university graduation, as a rule. In addition, project coordinators – experienced leaders who help organize the work of teams, support their mutual training and coordinate communication in the creative workshop's work are appointed. The head of the workshop with the help of coordinators and team leaders also systematically conducts additional events of various purposes.

Note that statistical studies can demonstrate a situational reaction in the diagnosis of such complex individuals' characteristics as SE and EI [16], so long-term qualitative research method become more valuable [3]. In particular, Case Study belongs to such research methods in education [21]. The case study includes the collection and analysis of several forms of data in order to gain an understanding of the processes [22]. It is necessary to deeply understand the situation under study and to possess a large amount of information about it. In the case of a retrospective analysis of the sources, methods, and conditions of the long-term work of "Geo-S" according to obtained results, Case Study has become one of the most suitable methods. Since the workshop permanent head took part in the study, several typical cases were described through in-depth interviews with current and former workshops' members. Analysis of cases permitted to highlight an appropriate skill that potentially can be formed for ESE development in conditions of creative activities of project students' teams [23], namely interpersonal and opportunity skill: teamwork, product development, leadership, and creativity. Figure 1 presents summary results of analysis for the proposed resolution of the research problem.



**Figure 1.** Formatting of skills for entrepreneurial behavior of future engineers within students' creative workshop.

At last, to determine the most significant events of the creative workshop based on the results of the participants' self-assessment, a survey and questionnaire were conducted, in which 12 current workshop participants and 10 "Geo-S" graduates took part. One of the questions was the rating proposed by the workshops' head during the students' team-work on projects. The total number of events evaluated by the rating was 21 points, so it was proposed to put ratings from 1 to 21 on the descending significance of options. The list included only events confirmed by the workshop head such as visiting professional exhibitions and forums, meetings of coordinators as team leaders, and others. Each item included a set of activities that were similar in focus. The differences were analyzed by comparison events' ratings of graduates of creative workshop and participating students.

### 5. Results and discussions

We believe that the following key students' characteristics developing with the creative workshop "Geo-S" are sources of skills formation for ESE and EI: proactiveness, competitiveness, learning orientation, teamwork, product development, leadership, creativity. Really, all of these points have been supporting by described rules of students' creative workshop "Geo-S". We cannot diagnose quantitative indicators of growth of characteristics because did not use psychological diagnostic tools [1] but we can confidently postulate the qualitative development: from low level of students' perceived desirability of engaging in entrepreneurship to clear demonstration of entrepreneurial behavior of the creative workshop graduates.

Finally, the significant results of the last survey will be considered. One of the conclusions was an imbalance in the mean ratings of some items among current and past workshop participants (table 1). Self-assessment survey is a widely used method in education [21] including meagering of entrepreneurial competencies in vocational training [3,16].

**Table 1**

Line	Creative workshop's events	Graduates	Students
1	Organization of publications with students in professional journals	5	12
2	Invitation to participate in innovation development contests at own university and the other ones	6	15
3	Regular meetings to exchange technologies, techniques, knowledge, request help from members of one project to members of another project	10	18
4	Systematic discussions of coordinators and teams' leaders	13	17
5	Hierarchical components in the workshop – firstly the problem or question is solved in the project team with the coordinator, then presented to the workshop's general meeting or to workshop's head	15	19

In our opinion, this difference characterizes professional development skills and attitudes of graduates including ESE и EI. Proactiveness is supported by events in lines 1, 2, 3 of table 1, competitiveness – by events in line 2, learning orientation – by events in lines 1, 3, teamwork – by events in lines 1, 2, 3, product development – by events in lines 1, 2, leadership – by events in lines 4, 5, creativity – by events in lines 3, 5 of table 1. In fact, experimental data have confirmed the results of the proposed explaining the problem's solution.

### 6. Conclusions

We offered, justified and experimentally confirmed model of skills formatting for entrepreneurial behavior of future engineers within students' creative workshop based on vocational training courses as a possible solution proposed solving the problem. The probable sources of targeted students' development are proactiveness, competitiveness, learning orientation, teamwork, product

development, leadership, creativity. Used didactic methods are well-known, they include problem-oriented project teams training. The obvious limitations are that in the framework of only professional training without entrepreneurial training and experience, it is impossible to guarantee the formation of high levels of entrepreneurial competencies. Conditions suggest the systematic implementation of supporting events in the work of students' creative workshop.

Directions for further research may include the explicit use of proven psychological techniques for diagnosing non-cognitive components of entrepreneurial competencies to monitor the effectiveness of different events and the developing process of students in general.

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