Creative potential of young engineers - preliminary results of examinations

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ABSTRACT: This article refers to the issues associated with creative thinking and selected aspects of the activity and creative attitude among students and assistants/doctoral students at the Cracow University of Technology, Kraków, Poland. The primary purpose of the article is to present the theoretical basis in creative thinking and features, as well as behaviours that are characteristic of the human creative attitude. The second purpose is to indicate the level of creative behaviour and reproductive behaviour among the examined groups. The results identify creative potential among academic teachers and students who are at the starting point of their higher education path. Comparisons are drawn in regard to the examined groups, which appears especially important as they are at different stages of their studies or academic careers.

INTRODUCTION

Human mental functions and behaviour are the realm of psychology. Creative activities of an individual form one specific field of research for psychologists. Despite detailed analyses, it can be assumed that ambiguity of the term creativity, allows for continuous seeking out novelty in regard to this sphere of human's life. The theoretical framework of the notion of creativity describes it as an individual feature of a person, his or her intellectual asset. In a different approach, one can speak of imaginative personality, internally rich and complex, which is driving force behind all creative enterprise.

At the same time, the distinction between imaginative personality and personality of creator must be stressed. Furthermore, one is said to be a creative person even if they have not created a masterpiece or made a significant discovery, yet their way of thinking and solving problems is unique and not mainstream.

The classic definition of creativity, as coined by Stein assumes that creativity is the process leading to a new creation that is utilitarian or needed by a group in a certain period of time [1]. Such a definition takes into account the relativity of novelty and value, pointing out that it is society that proclaims an invention as creative or not. In some cases, years must pass or even centuries before human creation is appreciated by new generations.

The creative process runs along different axes and involves a range of factors. The most fundamental are cognitive aspects connected with attentiveness, perception, imagination, categorisation of terminology, memory and thinking. The cognitive process that takes place when solving problems in creative ways is a key element in achieving a major goal, which is finding a creative solution.

On the other hand, relying on techniques to develop creative thinking is the source of creative evolution of an individual involved in the creative process. In addition to factors of a cognitive nature, it is immensely important to include motivation and interpersonal factors in the whole process of developing creative potential and in the creative activities performed by an individual.

Nowadays, the notion of creativity has grown to be very popular, even trendy in the dimension of professional activities and in private relations. Creativity and imagination are sought after among new employees. Thinking of imaginative ways of handling situations and task oriented goals is yet another asset in the process of studying, job searching, professional activities and everyday life.

Nevertheless, some people possess the qualities of a creative personality and have individual predispositions to create innovative solutions in wide range of problem complexity. However, due to training in creative thinking, everyone (as

proved by research in creativity training), has the opportunity to improve the hidden potential, so much needed in handling complex problems.

Technical studies, as well as studies in the arts and humanities, can reveal and develop creative capabilities among the students. The crucial element in this case is not the sole activity of students and their motivation to search for new solutions. It also includes overcoming stereotypes, such as the view still held by some academic teachers that future engineers should be mainly focused on calculations and algorithms and not to be distracted by searching for new, non-conventional ways to address current and emerging challenges and problems of their profession.

GENERAL OUTLINE OF CREATIVE ATTITUDE AND IMAGINATIVE THINKING

To get closer to how the creative thinking issue is dealt with in the literature, and what is meant by *creative attitude*, a few theoretical issues should be introduced that relate to both these terms. In classical works on the characteristics of creative thinking, Guilford, established the new term *divergent thinking* [2]. He proposed it be looked at and judged according to three areas. First, fluency - the number of ideas created, this number being the benchmark of fluency. Second, flexibility - which means changing the way of thinking, coming up with ideas that have the ability to transform and overcoming the stiffness of one's thinking. Third, originality - significant, extraordinary ways of solving certain tasks or problems. These are the elements of innovation, novelty and inimitability of the proposed solution. Guilford points out the qualities of the individual that should be involved in the creative process, which include the following: sensitivity to problems, in this context it means noticing inadequacies in certain situations, blank spaces in the subject knowledge, dissatisfaction with the way things are [3].

Cognitive processes that were mentioned are crucial in the creative process. Extensive research in this sphere point to interesting links between how these processes function and creativity itself. Not always do these results provoke an enthusiastic look at this activity. It has been proved that in spite of creative ways of thinking, individuals pay the costs of cognitive activities in other areas. A good example can be fewer parameters in how attention functions among creative ones [3]. Besides factors of a cognitive kind, another important group is emotional factors and motivational ones, and the social environment that can trigger creative developments or effectively block it.

In the research presented here, the author uses the KANH questionnaire of creative behaviours. It was formulated by Popek, whose definition of creative attitude is: *...personality of creative people is most visible through their creative attitude*, but *...creative attitude is formed (genetically and through individual experience) of cognitive quality, showing tendencies, attitude or urgency to transform the world of objects, phenomenon or oneself* [4]. In this framework, the person possessing a creative attitude is open to discovery and is not afraid of the world. He or she is characterised by curiosity towards the surrounding reality and inner motivation to change it and themselves.

The opposite of a creative attitude is a reproductive one. They both consist of two areas: cognitive and characterological. Cognitive spheres are dispositions of intellectual kind, the latter is represented by traits of character that enable standing up to one's own true cognitive potential.

RESEARCH OBJECTIVES

The first goal of this research was assessing the general creative abilities among first-year students, PhD students and assistants. The second goal was seeing which of the groups got higher grades in the creative attitude range.

RESEARCHED GROUP

First year students from the Department of Construction took part in the research (N = 30) and PhD students plus assistants who are alumni of Cracow University of Technology (N = 31). The research was conducted towards the end of summer semester 2013/2014.

METHOD AND PROCEDURE

The test for Creative Thinking-Drawing Production (TCT-DP) [5] has been used in this research. In this test, subjects take both versions of the test, one after the other. Subjects complete incomplete drawings in any way they like. They may draw whatever they like and how they like: everything is permissible and everything is correct.

Procedure: individual or group administration, testing with one version takes 15 minutes. This examination used only version A. Applications: for screening (creativity training; as a selective instrument in recruitment to schools or vocations), in individual diagnosis (enriched diagnosis of intellect; prediction of success in endeavours requiring creative functioning) and for research (studies of the nature, development and determinants of creativity and cross-cultural studies).

When one considers KANH - Creative Behaviour Questionnaire [6], one will find that the questionnaire comes in two versions: KANH-1 for school-aged adolescents and students and KANH-2 for teachers (psychometric parameters have

only been tested for KANH-1). Each version consists of 60 items in the form of sentences (in the indicative mood) addressing the respondent's behaviour in situations involving studying and action. The respondent rates the appropriateness of each statement on a three-point scale: true, partly true and false.

Procedure: individual or group administration, no time limit. This examination used only version KANH-1. The Creative Behaviour Questionnaire assesses creative aptitude understood as qualities of the human personality (creative attitude). The outcomes are assessed within four different scales: conformity (K), nonconformity (N), algorithmic behaviour (A) and heuristic behaviour (H). Other indicators can also be calculated, i.e. creative attitude, reproductive attitude, cognition and character. Applications: in counselling to assess creative attitude.

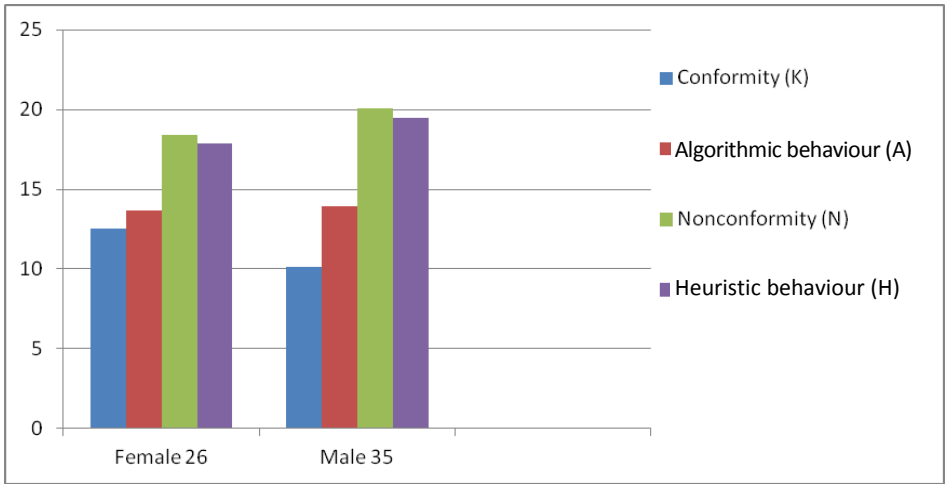
RESULTS

The results obtained in KAHN - Creative Behaviour Questionnaire, are as follows: significant statistical differences were observed within the researched group in the results regarding creative attitude (N,H) $F = 68.127$ $p = 0.000$ in comparison and contrast with the reconstructive group - conformity (K) algorithmic behaviour (A). The results on a scale, nonconformity (N), and heuristic behaviour (H) were considerably higher, irrespective of the individual's sex and position.

The results obtained indicated significant differences according to sex. These differences regarded scale of conformity (K). Women scored higher on this scale compared to men.

Table 1: Significance level between sexes on the scales KANH Creative Behaviour Questionnaire.

Variance analysis - significance level $p < 0.0500$			
Scale	F	*p*	
Conformity (K)	4.352	0.041	Reproductive attitude
Algorithmic behaviour (A)	0.130	0.719	
Nonconformity (N)	2.503	0.118	Creative attitude
Heuristic behaviour (H)	2.352	0.130	



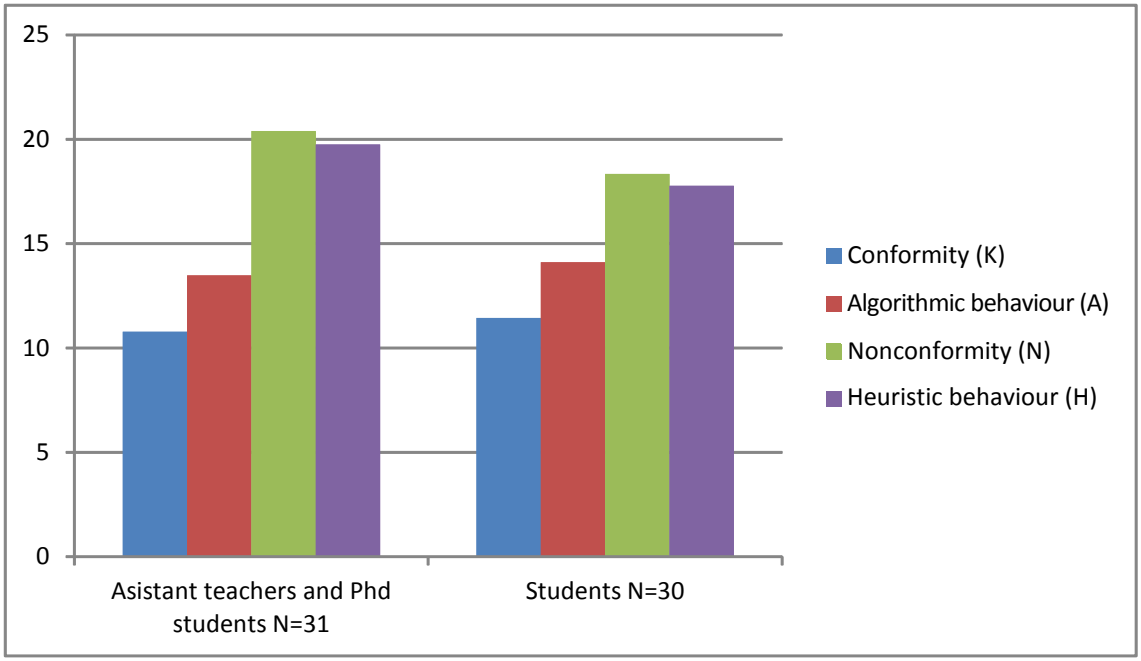
Graph 1: KAHN - Creative Behaviour Questionnaire: average results of men and women scores.

Graph 1, points to higher average results on the Conformity scale among the women examined. This difference proved to be statistically significant. However, in the remaining scales small differences between the sexes were noted, but they were not significant.

Significant statistical differences were observed when groups of young assistants and groups of students were compared; indicated by scales of nonconformity (N) and heuristic behaviour (H), assistants and PhD students got higher results than students. Therefore, it can be said that scholars presented a higher degree of creative attitude.

Table 2: Significance level on the scales that form creative attitude and the reproductive one. Results for group of tutors (N = 31) and PhD students and students (N = 30).

Variance analysis - significance level $p < 0.0500$			
Scale	F	*p*	
Conformity (K)	0.339	0.562	Reproductive attitude
Algorithmic behaviour (A)	0.570	0.453	
Nonconformity (N)	4.790	0.032	Creative attitude
Heuristic behaviour (H)	4.446	0.039	



Graph 2: Average results obtained by assistants (N = 31) PhD students and students (N = 30) (KAHN Creative Behaviour Questionnaire).

Graph 2 shows higher average results on nonconformity (N) and heuristic behaviour scales in the group of tutors and PhD students, as compared with the rest - students. This difference turned out to be statistically significant. In other scales the differences were subtle and not significant. The results of URBAN (TCT-DP) - CREATIVITY test did not indicate significant differences between the groups.

CONCLUSIONS

In analysing the results, it must be noted that the KAHN method that was used here in the Creative Behaviour Questionnaire, showed significant differences in creative and reproductive attitudes among assistants, PhD students and students of the Cracow University of Technology. The most important result seems to be the one indicating that in general, people examined scored higher results in scales of nonconformity, as well as heuristic behaviour.

The results demonstrate that the first year students starting their careers and the students who had graduated with an engineering degree, and who are the teachers of first-year students indicate some common features that point to creative attitude. The nonconformity scale reflects characterological aspects. High results in this area accent a high level of activity, a need to pursue goals, high aspirations and faith in one’s capabilities [7].

In addition, a creative attitude in the scale of heuristic behaviour connects with the cognition sphere. Results in this scale show: good logical memory, ability to learn on one's own, great flexibility in constructive and divergent thinking.

The areas of cognitive and motivational functioning described allow for an optimistic look into the results, which indicate that the group of assistants and PhD students obtained higher scores in two scales. The group numbered only 31, and the result suggests that the academic teachers are not burnt out, but are motivated and capable of innovative actions. The factor indicating a higher level of conformity among women confirms a stereotypical approach to sex.

On the scale of conformity that forms a larger attitude; namely, the reproductive one and also touches on the characterological area, the following traits are listed: compliance, subordination, passivity, dependence, low self-esteem and feeling of being afraid. All these traits can be found in the stereotypical picture of women.

The fact that a technical university is observed from the biased stereotypical perspective as a place connected with males rather females must be considered. The result refers to females who chose the technical type of university, and this result shows traits of character connected with gender. At the base of this phenomenon lies a strong stereotype of women, which means that pictures of *men* and *women* are very hard to change.

In summary, it must be stressed, that this preliminary research enabled a few major differences in the creative attitude area to be captured, in the groups of students, assistants/PhD students of the Cracow University of Technology. This research provides the basis for further exploration into behaviours that are of a creative nature among students and academic teachers at a technical university.

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