ECO-CREATIVE TRAINING: WIDER COMPETENCES PROFILING SESSION FOR GREEN DESIGN IN CHEMICAL ENGINEERING

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Abstract

As human populations increase in size, extent, and diversity, natural resource planners and policymakers must address growing concerns about a wide range of environments. To make the best decisions - for people and for nature - they need knowledge, skills and wider competences of creative thinking and decision-making, about how people, industry and natural environments influence each other. The human component of natural resource management became important issue worldwide. All forms of creative thinking can be an efficient mean to spread values and ideas important to influence people’s minds and have an effect on their ways of thinking and living, thus generating some sort of change that may drive to reduce the impact of human being on the environment. Creative training for green design is important tool where creativity, business ideas, environmental issues and social inclusion come together. Creative design, in fact, thanks to its huge power of communication and capacity of interpreting the contemporaneity is particularly indicated to diffuse a message among young generations, especially engineering students, which are the ones who can really have possibility to change reality. Our research was aimed to reveal what effect it has of a two-day of training in the field of creative thinking on the activation of the creative potential of chemical engineering freshman students. Chemical engineers design both products and processes, and manage and optimize their performance in order to ensure safe that are economically viable and acceptable to the environment. It is important to note that chemical engineers must be able to respond to changing conditions of production. Thus, the success of chemical engineering is not only dependent on a formal or explicit knowledge, but - more than in the science-driven, such as chemistry - is also not explicable or implicit knowledge. Classified information is essential for the creation of tacit knowledge, which is crucial for the ingenuity of creative attitude characteristic of the humans. Hence, this present paper highlights the most appropriate creative thinking techniques that the educators and trainers employ to motivate the green abilities seekers most effective and inspirational for the upcoming generation.
Keywords: chemical engineering, wider competences, creative training, eco-creativity, green design

Introduction

The “green” revolution represents one of the most exciting opportunities of the twenty-first century. Governments across the globe have developed incentive programs, directed research money, and emphasized the creation of “green collar” jobs. Green jobs are those jobs that maintain, preserve, and restore the environment while providing a liveable wage. Recently the U.S. Department of Labor’s Bureau of Labor Statistics (BLS) proposed a definition of green jobs as those jobs “related to preserving or restoring the environment”. The Bureau of Labor Statistics lists seven economic activities under which green jobs fall [1]:

1. Renewable energy
2. Energy efficiency
3. Greenhouse gas reduction
4. Pollution reduction and cleanup
5. Recycling and waste reduction
6. Agricultural and natural resources conservation
7. Education, compliance, public awareness, and training.

These economic activities result in the production of green goods and services that fall into four types [1]:

1. Direct green goods and services (including weatherisation of buildings)
2. Indirect green goods and services (for example, goods containing recycled materials)
3. Specialized inputs (for example, wind-turbine blades and mass-transit rail cars)
4. Distribution of green goods that fall into one of the first three categories.
Couple an interest in green issues and a desire to teach and the result is a career educating people about environmental concerns. This career direction can take many turns. Advocacy groups often hire people to give presentations on environmental topics to educational institutions. There also is a need for educators and trainers who care about the earth and have a love for nature to share their knowledge with pupils, students and adults. Career options vary widely. A specially and important role plays green chemistry. Green chemistry is the design of products and processes that eliminate or reduce significantly the use and generation of hazardous substances and the prevention / reduction of environmental / safety and health impacts at the source [2]. "Green" often focuses on the chemical itself, including environmental aspects only. Sometimes safety and handling aspects are included.

The insight of enormous large amount of chemical engineering waste triggered activities within the chemical industries to reduce waste generation by different measures such as using different and more appropriate / "greener" solvents, or to develop synthesis routes using fewer less steps thus avoiding waste intensive purification steps [3]. This was the eye opener for a broader view that brings the full life cycle of chemical engineering products (Figure 1) into focus, since it could be shown that such approaches can also save high amounts of money, thus rendering companies more competitive. As for chemicals in the environment, it has been learned that several techniques for the reduction of the input of chemicals into the environment are available [4]. However, it was found that each of these approaches has its specific shortcomings. Therefore, additional approaches such as people handling and using the compounds, i.e. doctors, pharmacists and patients. Another approach that focuses on the properties of the compounds came into focus - benign by design - the targeted design of a compound from its very beginning. These two strings of discussion can be connected by providing a broader view taking into account all environmental, social and economic issues. Along the life cycle of an active chemical ingredient and an adjuvant, different issues are of importance with respect to sustainability. These are roughly depicted in Figure 1.
As we can see from the Figure 1, design activity has a special and important role at entire life cycle. Considering green design, the following requirements should be adopted: effectivity, efficacy, specificity, side effects, environment load, healthy and safety issues [4]. At design activity, a lot of knowledge, skills, and creative abilities should be engaged for competitive and innovative design. The innovative success of chemical engineering is on the one hand based on rigorous research and development services, but on the other hand also on a high level of flexibility and customer focus [5]. Thus, the success of chemical engineering is not only dependent on formal or explicit knowledge, but - more than in science-driven sectors such as chemistry or biotechnology - also on non-explicable or implicit knowledge.

There are two types of knowledge: an implicit (tacit knowledge), existing only in the mind of the man who has it, generated through experience and not fully conscious, manifesting itself only through skilful action and overt (articulated, excavated) (explicit knowledge, formal knowledge) expressed in the form of characters and saved [6]. In
the 50s of last century it was observed that the existence of tacit knowledge is characterized by the fact that we know more than we can say. Often, people gain knowledge through its active create and organize their own experiences. Explicit knowledge, which is expressed in words and numbers, represents only “the tip of the iceberg top” of the full body of knowledge. The concept of tacit knowledge is based on three arguments: 1. The real discoveries can be made using articulated the principles and algorithms, 2. Knowledge is widely attainable, but for the most part is personal, 3. All knowledge is implicit or derived from it. [6] Implicit knowledge is an important kind of knowledge. It is knowledge not expresses explicitly in a character (e.g., in words) by its holder. It is included in the personal experience of its owner. Its formation depends on so elusive traits as personal beliefs, attitudes and values. Implicit knowledge is personal, context-specificity. Consequently, it is subjective, based on the experience (senses), more associated with the practice. It is created “here and now”. In a specific context. One of the characteristics of knowledge in general is that its use in the course of solving the problems by a person or group of persons leads to the foreground. New knowledge - initially usually implicit - through its documentation and then made available (through presentations, publications, databases, patents, etc.) becomes explicit knowledge (formal).

Creativity as ambiguous concept is also the subject of interest of many disciplines in the humanities, social as well as technical [7]. In terms of psychological issues related to the work were and are analysed in terms of, inter alia, cognitive, personality traits, developmental processes of social phenomena, psychometrics, as well as practical applications such as training and workouts. Analysing the concept of creativity, should pay attention to the kinds of values and domains. I wish to recall the typology, which presents four domains of creativity, distinguished by the type of activity and predominant purpose [8]. Thus, cognitive values will be aimed at discovering, investigating the truth and the domain of this kind of action will be learning. Aesthetic values will develop in the arts and will show the beauty. The third group of values, in turn, pragmatic values are aimed at usability and creativity is the domain of inventiveness. And as the fourth, the last mentioned are the ethical values which aim at the good of the public domain of creative activity. This typology gives you a broader perspective on human creative activity. It can be assumed that creative scientist is a man focused, concentrated only on the values cognitive- or search for the truth, but considering his creative work more broadly, we note that it can realize the aesthetic and pragmatic.
The creative activity of engineers, which are assigned a pragmatic values, the goal is inventiveness, which is an indispensable element of progress and improve quality of life. However, as shown by the surrounding reality creative engineers move both in the world of pragmatic and cognitive and aesthetic. To cite at this point it is worth interdisciplinary field of science that is where the development of biotechnology and invention, we find the values of all of the aforementioned domains. For example, the creative aesthetic value of biotechnology can be seen in the actions of aesthetics implant and through innovative effects of the active ingredients in cosmetic anti-ageing [9].

One of the recent EU green initiatives project STRENGTH [10] provides strategic advice on formulation of a green economy strategy, engaging global best practices and making connections to global network of green economy lessons learned. It analyses the global trends in green economy with focus on clean technology investments and fiscal instruments to generate efficient use of energy, water, mining, building, transport, and wastes. The project objectives are focused on introduction of the “green abilities” concept to create new opportunities of vocational education and training (VET) teachers and systems to build up green employability skills and further ecological awareness development in job seekers. In this way participants in VET will acquire knowledge and creative ability for new generic employability, green skills and wider competences for performance of personal development, employability and introduction in the European labour market [10].

In spite of several creative training methods aimed for green design, an evidence of effectiveness is still lacking. Therefore, our research had the following two goals: (1) To assess the general level of wider competences of creative thinking in freshman students of the Faculty of Chemical Engineering and Technology University. Cracow. (2) To reveal the impact of a two-day eco-creative training on the activation of the creative potential of participants in such activities.

**Eco-training within the creative potential of future engineers**

The education of engineering students, in addition to expertise, which gain understanding and then use in their work is the primary goal of higher education. It necessary to consider should also be inspiring, activating and production of creative attitude. Exposing systematic thought processes influence - stimulating, it stimulates
the creation of new solutions, the search for imperfection and to propose eliminating them and make improvements [11]. The introduction of a structured system of humanising the process of engineering education, which is attractive to students ensures the personal development of an engineer-creator. Apart from traditional theoretical lectures, multiple training and workshops play a major part in this process. Using a range of methods and techniques, e.g. educational games, art activities, communication exercises, exercises in pairs, work with the body, psychodrama and relaxation techniques, pedagogical work can be used to activate different ways of receiving and processing information by students [12].

Stimulate creative thinking is a factor that mobilizes for action, while at the same time an incentive to self-stereotype thinking, questioning and stimulate cognitive curiosity. Training creative thinking, it is aimed at developing individual or group of individuals, which has already defined the creative potential, but also has many internal blockages that inhibit the full development of its creative possibilities. These locks are often intellectual, emotional and social development. Critical thinking, problem-solving skills and communication skills are more important than simply knowing the content itself [13]. Motivational processes indicate that learners are self-motivated and willing to take responsibility for their successes or failures. Behaviour refers to the characteristics of the strategies that students utilise to optimise learning and / or training [14].

Psychological studies conducted in the mainstream of cognitive shown that intellectual operations such as the operations of abstraction, metaphorical thinking, making associations, inductive and deductive reasoning or making transformation, are the basis for creative thinking process [15]. It worth noting that these operations are commonly used in processes thinking and problem solving, and creative thinking come so leads to original, unusual solutions, uses the typical cognitive mechanisms.

Another important aspect of the training of creative thinking is its character group. Working in the training group, favours the development of motivation and interpersonal communication. Active listening, rewarding, skill constructive criticism, developing empathy is an element of personality, each participant training. Interactions between training participants simulate the interaction and joint problem solving situations in the future teamwork. Interaction has been deemed one of the most important component in open learning environments where multiple learning objects are used [14]. Creativity training course's interaction framework has been seen
as learner-learner, learner-instructor and learner-content interaction. Learner-learner interaction refers to two-way reciprocal communication between or among learners who exchange information, knowledge, thoughts or ideas regarding course content, with or without the presence of an instructor. Learner-instructor interaction consists of two-way communication between the instructor of a course and learners. Learner-content interaction is a process of individual learners elaborating and reflecting on the subject matter or the course content [14]. Aforementioned interactions were also included at eco-creative training, boosted also by project STRENGTH objectives which were promoted during training (Figure 2).

![Figure 2. Creative training for green design in chemical engineering](image)

To boost green design, an eco-creative course was designed considering different techniques as brainstorming, “crushing technique” creating analogies, “sculpture” - work with the body, creating metaphors. Students formed teams of creative, leading to the approval of freely experimented with ideas, made mistakes, but also learned from each other, acting in a given context for the project team and practising the ability to achieve innovative results.
**Eco-Creative training course format**

The creative thinking training has been designed for 15 periods of active learning in a two-day course. All participants of the training were freshman chemical engineering students at Faculty of Chemical Engineering and Technology at the Cracow University of Technology. Gender distribution of students was not evenly, there were just eight male students out of 49. Students were divided into eight teams with one male student in each team. Thus, an impact of male students at course analysing and problem-solving tasks was normalized.

The creativity training consists of three essential parts: (1) Acclimatization and team building; in the first phase it is the most important to know each other and to establish good communication (skilful listening, asking questions) between persons belonging to particular teams. It is also important to clarify mutually expectations, rules and standards that are applied to training participants. (2) Heuristic rules; in the second phase is the most important fixation (introduced in the first phase) heuristic rules that are applied during a workout and problem-solving activities. In this phase, a further collaboration in teams should be promoted. At the beginning, we point to the refraining from immediate judgement of the person or an idea. A “Provisional list of ideas murder” or phrases that inhibit the activity of creative and motivational-emotional participants is dealt. These phrases must not be used during the training. Participants have to encourage each other to generate and presenting surprising and original ideas. (3) Empowerment; Mutually peer- and / or instructor-scaffolding training to reinforce participants to cross the clichés of thought. In this phase a violation of rules could appear and it is important to warn students to be streamed with the training. Instructor must control the use of by the course design not adopted standards and rules, and control them in tolerance field. The last third phase of the training period is noticeable shift in a way how we communicate participants in teams (and between the teams). There was also a change in the quality and quantity of the solutions proposed in the exercises. A context, exercises and suggested materials used in two-day creativity training were adopted from [8]. This manual constitutes a key set of principles and practice concerning the issues of the training.

At DAY 1 training exercises were focused on developing interpersonal skills which enhance group climate, the communication and cooperation of the students. The exercises in interpersonal skills were aimed for a better understanding of students who are in a team, and to increase team's cohesion by giving it a name and
presentation of the totem (logo) of each team. At this stage, the students were given crayons and large sheets of paper and were asked to draw a character (totem) which will be the symbol of their team as well as come up with unusual names (Indian style) that reflect the most important characteristics. Then the whole group has presented eight works that depicted the totems of each team, and read atypical "Indian" names. Another exercise was to present in the form of non-verbal sculptures (created by all the members of one team). Sculpture purports represented a problem or a defined concept (often abstract). Each of the eight teams presented another problem or concept and the rest of the group was tasked guess this wordless message. The next exercise was creating a common work - drawing, which was presented in the form of simple signs, symbols referred to the current mood of individual team members. The works were presented to the groups. The teams also worked on overcoming the perception and use of the objects. The next two exercises were the motivating group exercises. The first of them was to find as much as possible defects in products; this technique is called reverse brainstorming session. In this case, a person simulated the object and was open to criticism by peer students. The second exercise from this motivation set was aimed for improving the product, namely with the introduction of step-by-step changes at the facility. This time, the members of each team used self-selected object, which was subjected to changes. Teacher merely pointed out that this should be the subject of consumer and well known to all participants in the training.

At DAY 2 of creativity training course, the overarching objective was to develop the capacity for mental operations. Proposed training exercises were abstraction, deductive reasoning, inductive reasoning, making associations, and metaphorising. An exercise to develop abstracting was oriented to stimulation of the imagination and of activation of semantic fields while moving away from stereotypical notions associated with the analysed object. The teams presented such definition of objects (e.g., a lamp, a window, a chair) using language puzzles. The exercise of deductive reasoning was the removing of the proposal for unusual, the output-based state of affairs. In the exercise of inductive reasoning test, teams solved the analogy with the same form of analogy. Metaphorisation exercise consisted of completing sentences in many different ways. This task was aimed, as in the case analogy, to find an accurate description which facilitates understanding of the demanding problem.

The final exercise was a motivational group exercise and contained the elements of crushing, repairing and building. It was necessary to create a project of an ideal city.
The teams were working simultaneously on the project of the settlement for women, men, fun of nature, and chemical sciences fun.

Since the teams were eight, two teams were parallel assigned to create a project for the same group of people. To perform this exercise, different types of material were used: cardboard and paperboard boxes, colour paper, crayons, plastics pieces and artefacts, metal containers and other items of the daily use. Most of the creations were spatial character and resembled a form of artistic technique which is collage. Presentations of created artefacts and mind models were original and distinctly different from each other (Figure 3). The aims and objectives that guided the training can be carried out as realized.

**Methodology**

The sample, instruments and data collection and analysis are described in the following subsections.
Sample

The sample was drawn from the freshman chemical engineering students at the Cracow University of Technology (N=100). The students were divided into two groups. The experimental group included creative thinking training participants (N = 49), while students participating in other activities humanistic (N = 51) formed the control group. The study was conducted in the premises of Cracow University of Technology at the end of the summer semester (April and May 2015). In sample were more female (N=78) than male students (N=22).

Instruments

The test for Creative Thinking-Drawing Production (TCT-DP) [16] has been used in this research as pre- and posttest. The TCT-DP test has been already exploited in our previous study and it was proved as a reliable and valid instrument [17]. 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.

When we consider KANH - Creative Behaviour Questionnaire [18], 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 and data analysis

Procedure at TCT-DT test: individual or group administration, testing with one version takes 15 minutes. This examination used first version A. and after B. It should be noted that version B is a mirror image version of A. Applications: for screening (creativity training; as a selective instrument in recruitment to schools or vocations), in individual diagnosis and for research (studies of the nature, development and determinants of creativity and cross-cultural studies). Reliability on pre-and post-test are: Pre-test: Cronbach's alpha = 0.73, Post-test: Cronbach's alpha = 0.76.

Procedure at KAHN surveying: 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), Algorithmic behaviour (A) Heuristic behaviour (H) Nonconformity (N). Other indicators can also be calculated, i.e. creative attitude, reproductive attitude, cognition and character. Applications: in counselling to assess creative attitude.

Reliability of Cronbach's alpha of KANH survey is 0.61 (n=60 items), what is regarded as weak to moderate internal reliability, shown in Table 1.

Table 1. Reliability information Cronbach’ α on KANH subscales

<table>
<thead>
<tr>
<th>Creative Behaviour Questionnaire KANH</th>
<th>Subscale</th>
<th>Cronbach’ α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproductive attitude</td>
<td>Conformity (K)</td>
<td>0.52</td>
</tr>
<tr>
<td></td>
<td>Algorithmic behaviour (A)</td>
<td>0.50</td>
</tr>
<tr>
<td>Creative attitude</td>
<td>Heuristic behaviour (H)</td>
<td>0.62</td>
</tr>
<tr>
<td></td>
<td>Nonconformity (N)</td>
<td>0.71</td>
</tr>
</tbody>
</table>

The study was divided into two phases and during the conduct used two methods discussed above.

In the first stage at the beginning of the course we asked the respondents from experimental and control groups to perform drawing a Test of Creative Thinking version A. This step was a pre-test. In the second stage at the end of the course after 15 hours (creative thinking training or other activities humanities) again asked the respondents from both groups to perform drawing a Test of Creative Thinking Version B, which was post-test and complete the Creative Behaviour Questionnaire KAHN.

Results

The first most important result obtained compared to the results obtained in the test for Creative Thinking-Drawing Production (TCT-DP) is a distinct difference between pre-test and post-test. Table 2 depicts the average scores on the subscales where is M-mean and SD-standard deviation. All examined students significantly higher scored at post-test than the pre-test in the test for Creative Thinking-Drawing Production (TCT-DP).

Table 2. Paired Samples Statistics-average scores on pre and post-test on TCT-DP

<table>
<thead>
<tr>
<th>Creative Thinking-Drawing Production (TCT-DP)</th>
<th>All Group</th>
<th>M</th>
<th>SD</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Post-test</td>
<td>31.26</td>
<td>12.23</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Pre-test</td>
<td>28.41</td>
<td>10.76</td>
<td>100</td>
</tr>
</tbody>
</table>
T-test revealed significantly differences between post- and pre-test where was $t(99)=3.22, p=0.002<0.05$. The all group of surveyed students ($N=100$) achieved higher scores in post-test. The obtained result indicates that the screened students showed more creative drawing in the second version B test for Creative Thinking-Drawing Production (TCT-DP). This may indicates on a more flexibility in the way of thinking with the passage of time, and despite of the similarities of tasks.

Levene's Test of equality of variance across groups was performed in advance to ensure the assumption of equal variance was met ($F(1,98)=3.697, p=0.057>0.05$). While T-test revealed not significant differences in creativity scores between experimental and control group $t (98)=-0.845$, ($p=0.40>0.05$). The basic descriptives of creativity gain (a difference between post- and pre-test of TCT-DP) are shown in Table 3. The experimental group gained higher on creativity but differences are not statistically significant ($p=0.40 >0.05$).

<table>
<thead>
<tr>
<th>TCT-DP test</th>
<th>Group</th>
<th>Number of students</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>51</td>
<td>2.11</td>
<td>7.97</td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>49</td>
<td>3.61</td>
<td>9.66</td>
<td></td>
</tr>
</tbody>
</table>

Some significant differences ($p<0.05$) emerged in the analysis of the dependent variables, which consisted of 14 key assessment criterions (D1-14), used for evaluation of the drawings of the tested students. Analysis of variance revealed statistically significant differences between the groups ($p<0.05$) at two assessment criterions. At criterion of D12 (Unconventionality-Any usage of symbols or signs) an experimental group scored higher, the effect size is regarded as small (eta squared=0.03) while at criterion of D13 (Unconventionality- Unconventional use of given fragments) a control group scored higher, the effect size is regarded as moderate (eta squared=0.08).

In Figure 4, the results of KAHN survey subscales are depicted. Mean results in subscales (heuristic behaviour and nonconformity) which relate to creative attitudes are higher in both groups compared to the results obtained in forming the attitude of reproductive subscales. Variance test of between-subjects effect across behaviour subscales revealed non-significant differences ($p>0.05$).
Conducted multiple regression analysis, a significant difference was found (p<0.05). Algorithmic behaviour significantly affects students' creativity with negative beta weight (beta = -0.259), Table 4. The learners with prevailing algorithmic behaviour were ranked lower at creativity test than their counterparts. Higher was intensity of algorithmic behaviour; lower was creativity gain after a two-day creative training course for green design.

Table 4. Multiple regression on the subscales of the test KAHN

<table>
<thead>
<tr>
<th>Creative Behaviour Questionnaire KAHN</th>
<th>Subscale</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td></td>
<td>19.44</td>
<td>2.62</td>
<td>0.010</td>
<td></td>
</tr>
<tr>
<td>Reproductive attitude</td>
<td>Conformity (K)</td>
<td>-1.49</td>
<td>-0.044</td>
<td>-0.38</td>
<td>0.702</td>
</tr>
<tr>
<td></td>
<td>Algorithmic behaviour (A)</td>
<td>-9.98</td>
<td>-0.259</td>
<td>-2.36</td>
<td>0.020</td>
</tr>
<tr>
<td>Creative attitude</td>
<td>Heuristic behaviour (H)</td>
<td>-2.50</td>
<td>-0.073</td>
<td>-0.50</td>
<td>0.617</td>
</tr>
<tr>
<td></td>
<td>Nonconformity (N)</td>
<td>-1.62</td>
<td>-0.053</td>
<td>-0.36</td>
<td>0.716</td>
</tr>
</tbody>
</table>

Basics descriptives on creativity gain across sex revealed a weak gain in creativeness at male students over female (Mm=3.10, Mf=2.78). Analysis of variance
between groups revealed no statistically significant differences, $F(1)=0.21$, $p=0.88 > 0.05$.

Reported standard deviations of the TCT-DP results are regarded as high, especially those in the experimental group. This indicates that results were widely spread. Some of students were advanced more at creativity training; while some of them were decreasing markedly, perhaps of too much congested training schedule or of articulation phases which were conducted in a two-day training course.

**Conclusions**

Our research yielded some interesting findings. The results indicate that students at Faculty of Chemical Engineering and Technology achieved higher scores in the post-test Creative Thinking Drawing Production in the whole group. It can therefore be concluded that the test group of students after participating in the activities of a humanist showed a more creative possibilities than at the beginning of classes. This result can be interpreted in two ways. Participation in the faculty of humanities generally has a beneficial effect on the development of creative potential. As a result this may indicate that the 15 periods of training creative thinking perhaps is not enough for full mode of green design development. Thus, a course needs modification in terms of allotted time. In general, an initiative of eco-creative training is regarded as successful. The results show significant differences between the experimental group and control group to analyse detailed evaluation criteria drawings and Creative Questionnaire subscales KAHN behaviour. The number of examined female students was considerably large but there were no differences in behaviour between the sexes creative in the study group. It should, however, refer to the theoretical assumptions, which are included in the introduction. The concept of knowledge is not overt, which assumes that certain issues exist only in the mind of the man who has it. This knowledge is produced as a result of experience and at the same time is not fully conscious. So, given these assumptions, you can count on a delayed effect of the training of creative thinking that can manifest itself greater openness and exploration by students, different ways of solving problems.

Any action that is aimed at developing the creative possibilities entity, and at the same time allows interoperability in the group, it is his actions creative in itself. Developing creative abilities of future engineers is a task that obviously and
unambiguously activates and expands knowledge (explicit and implicit). Although the effects of these interactions can present themselves after a certain time of incubation.

Finally, it must be highlighted that education and training in green engineering and design are the key weapon to tackle the current needs. Green engineering has to be introduced at academic and industrial levels to create a critical mass of engineers and scientists to undertake this challenge as soon as possible.

References


