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Schoolchildren in Poland learn vital skills from a *Young Architects* programme

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ABSTRACT: The primary school programme discussed in this article has elements of spatial education limited in scope. A primary school person does not learn systematically the principles of the valuable shaping of architectural and urban space. This deficiency is difficult to rectify in high school, where the topic is presented selectively and fragmentarily. As a result, the majority of adults are not able to participate in public debate on shaping their environment. The spatial education programme, *Young Architects,* organised for separate age groups at the early, middle and late school educational levels has been designed to address this deficiency. For the purposes of this study, a sample of 61 students was used. Students were surveyed before and after a workshop, where criterion-based cognitive, psychomotor and interpersonal skills were assessed. It was found through the study outlined in this article that the competencies of students increased after participation in the programme.

INTRODUCTION

Global industries and advances in technology cause rapid changes in the physical, economic and social environment [1]. This leads to rethinking about how to inspire the next generation of city - and other environment - shapers. The future quality of the environment will be a central focus and *playground* for the children of today [2]. Architectural education offers several opportunities for children, starting in kindergarten, followed by pupils in school and later students, who can practise different architecture-based activities [2-5], with these results:

- improvement in sensory awareness of different spaces;
- improvement in team learning with practice roles, facing the rights and responsibilities in the built environment;
- the bridging of gaps between old and new designs and shapes, including heritage designs;
- an understanding of sustainability in different environments;
- the enhancing of critical thinking, problem-solving, decision-making in dealing with real world problems and opportunities;
- improvement in design thinking in team learning, where empathy, problem-identification and ideations play a central role;
- the experiencing of sensitivity and imagination, taste and critical decision-making;
- exploration of the nature of architecture as a creative cognitive task, where created designs may bring together different reflections on humanity, culture, heritage, nature, society and business.

Information and communications technology (ICT) can support the teaching and training of architecture in different contexts and educational settings. Information and communications technology can support all educational levels, from kindergarten to university. It attracts children and so can be a good facilitator of early architectural learning. Children can sift through information to see the type that is useful and how to make compromises in a virtual environment; later they can get the big picture of the real world [6].

Architecture education occurs even in pre-school, as integrated themes that are close to everyday life, to different domains of knowledge and experiences. In pre-school, children learn to respect both the natural and the built environments. Thus, they want to act in the environment in a way that preserves the cultural and aesthetic values.

In primary and secondary school, students are able to learn concepts by looking at the built environment from a different point of view. Visualisations and representations of environmental subjects' interrelationships with the built environments provide a good basis for teaching architecture at schools. Moreover, when children or students are in close contact with architecture and design, their creative potential might increase and their sense of responsibility for the world around them can increase [1][2].

The spatial education programme, *Young Architects* (*Młodzi Architekci*) [7], is organised for separate age groups at early, middle and late schools. It is implemented in three separate modules: *We Build*, *We Design* and *We Visualise*. The *We Build* module is a focus on the manual construction of building mock-ups by students [8].

It exploits the natural tendencies of children to build, which allows them to develop manual skills, as well as stimulating spatial imagination and promoting architectural and aesthetic awareness. The spatial education programme was developed and reviewed by academic teachers and is adjusted by school educationalists [9].

The basic content of the programme for all age groups includes introducing students to the elementary principles of designing elements of the urban landscape; the principles of building statics; the specification of building materials; possibilities of mock-ups with simple, generally available materials; and the vocabulary needed to talk about features and the quality of buildings.

The competencies of the participants of the *Young Architects* programme are established before participation in the programme and after it, based on six assessment criteria [10-12]:

C1: The skill of manually making a spatial model of a given structure.
C2: The skill of being able to imagine structures in space (3D).
C3: The awareness of the situation in which a structure is stable.
C4: The skill of identifying the basic materials used in the arts and in construction.
C5: The skill of using spatial elements and light in modelling.
C6: The skill of working in a team.

The main purpose of the research was to show differences in the students' expertise before and after participation in the programme. In particular, these differences are measured across the grade of the student and gender.

METHODS

Sample

The sample for the study consisted of students who were attending a primary school in a rural area. Fifteen students, including six girls and seven boys, were in the third grade. Twenty-four students, including 13 girls and 11 boys, were in the sixth grade. Twenty-two students, including eight girls and 14 boys, were in the eighth grade. Overall, 61 students took part in the study (see Table 1). The age of the students was between eight and 15 years (see Table 2).

Table 1: Grade and sex.

		Sex					
		Females		Males		In total	
		N	%	N	%	N	%
Grade	3	6	22.22	9	26.47	15	24.59
	6	13	48.15	11	32.35	24	39.34
	8	8	29.63	14	41.18	22	36.07
	Total	27	100.00	34	100.00	61	100.00

Table 2: Students' age distribution.

Age	Number	Percent (%)
8	2	3.28
9	13	21.31
10	1	1.64
12	24	39.34
13	5	8.20
14	14	22.95
15	2	3.28
Total	61	100.00

Instruments

The study was performed by questionnaire, completed by the participants. The questionnaire measured the six competencies described in the introductory part, with a six-point Likert scale. The result 1 denoted a *very high* rating, while the result 6, a very low rating. For easy interpretation of tables showing means and graphs, the raw results were recoded to converse values, e.g. higher results point to higher competency and *vice versa*.

Procedure and Data Analysis

In the classroom, students were invited to complete the questionnaires as a pre- and post-test. Data from the questionnaires were collected and descriptive analyses were conducted to present the student basic information, and the mean scores of dependent variables. The Cronbach's alpha coefficient was calculated to assess the reliability of the questionnaire. The Levene's test for equality of variances was used. A two-way ANOVA (analysis of variance) with repeated measures was applied to find within-subjects' contrasts. Multivariate analysis was conducted to find and confirm significant relationships between groups with an effect size expressed with partial η^2 (eta squared).

RESULTS

The data were used to analyse changes in the self-appraisal in the six competencies, as well as to analyse the change in self-appraisal between the three classes to determine whether the effectiveness of workshops was different for the three classes. The 61 students were successfully surveyed both times in the presence of the teacher/mentor.

- The analysis of the data collected from the workshop is based on survey items where Cronbach's α coefficient for the pre-test was 0.76, while Cronbach's α for the post-test was 0.79 - what is considered as moderate reliability.

- The pre- and post-test data were analysed to determine the mean (M) and standard deviation (SD) for each competency (C1-6). For the competency C1: The skill of manually making a spatial model of a given structure, students' achievements are shown in Table 3.

Table 3: Means and standard deviations for competency C1.

Grade	M		SD		N
	Before	After	Before	After	
3	3.40	4.33	0.83	0.61	15
6	3.17	4.88	1.00	0.61	24
8	3.68	5.10	0.95	0.75	22
Overall	3.41	4.82	0.95	0.71	61

A linear relation between independent (predictor) and dependent (criterion) variables was assumed, i.e. between *grade* and *mean*. It was expected that increases in one variable would be related to increases or decreases in another.

Further descriptive analysis indicated that the test for homogeneity of variance was non-significant, meaning that the sample exhibited characteristics of normality required for analysis under the assumptions of the general linear model. The Levene's test for equality of variances showed no statistical significance both for pre-test with F (2.58) = 0.25, ($p = 0.78 > 0.05$) and for post-test with F (2.58) = 0.72, ($p = 0.49 > 0.05$).

A two-way ANOVA with repeated measures was performed to test within subject how the workshop enhances learning by grade. Statistically significant impacts were not found with $p = 0.09 > 0.05$. Test of between-subject effects revealed that all three groups (grade 3, 6, 8) made progress in competencies, and this progress was estimated as equal across the groups. The effect size $\eta^2 = 0.11$ was moderate, meaning that the workshop significantly improved students' skill of manually making a spatial model of a given structure.

The analysis of the results for competency *C2: The skill of being able to imagine structures in space (3D)* is depicted in Table 4.

Table 4: Means and standard deviations for competency C2.

Grade	M		SD		N
	Before	After	Before	After	
3	3.07	3.80	1.00	1.08	15
6	4.08	4.62	1.07	0.76	24
8	4.45	5.09	0.73	0.61	22
Overall	3.96	4.59	1.06	0.93	61

Levene's test for equality of variance was not significant ($p > 0.05$), which points to the normality of the distribution for both pre- and post-test. Using analysis of variance of mean differences expressed as skill gain revealed a significant and strong effect of the workshop on learning ($p = 0.00$, $\eta^2 = 0.33$) in all groups, while a two-way ANOVA with repeated measures revealed non-significant changes ($p = 0.81$) across the groups, from pre-to post-test. Students from all grades improved skills of 3D structure visualisation.

Analysis of the results of the workshop, based on surveys for competency *C3: The awareness of the situation in which a structure is stable,* is shown in Table 5.

Table 5: Means and standard deviations for competency C3.

Grade	M		SD		N
	Before	After	Before	After	
3	2.80	4.66	0.77	0.72	15
6	3.45	4.62	1.14	0.92	24
8	4.72	5.19	0.88	0.67	22
Overall	3.75	4.83	1.23	0.82	61

Levene's test revealed no significant differences ($p > 0.05$), which means that variances are equal across the groups in the study, both for the pre- and post-test.

A two-way ANOVA revealed that changes between groups was significant ($F = 7.03$, $p = 0.002$). This means that the groups had significantly different changes from pre- to post-test. The overall change was statistically significant ($p = 0.00$) with strong effect size, $\eta^2 = 0.37$.

The results after the workshop were higher than before the workshop. The magnitude of the change significantly varied between classes, where the effect was also estimated as strong with $\eta^2 = 0.19$. A Scheffe post-hoc test revealed significant differences ($p = 0.00$) in competency gain between grade 3 and grade 8 in favour of grade 3 and between grade 6 and grade 8. Between grade 3 and 6 no significant differences were found on skill gain.

Analysis of the results of the workshop, based on surveys for competency *C4: The skill of identifying the basic materials used in construction,* is shown in Table 6.

Table 6: Means and standard deviations under each type of experimental condition.

Grade	M		SD		N
	Before	After	Before	After	
3	3.40	4.73	0.98	0.59	15
6	4.17	4.67	0.70	0.64	24
8	4.69	5.23	0.56	0.69	22
Overall	4.17	4.89	0.87	0.69	61

A two-way ANOVA revealed that interaction between groups was significant ($F = 4.63$, $p = 0.014$). This means that the groups had significantly different changes from pre- to post-test. The overall change in skill gain was statistically significant ($p = 0.00$) with strong effect size $\eta^2 = 0.31$. The results after the workshop were higher than before the workshop.

The survey concerning competency C4: *The skill of identifying the basic materials used in the arts and in construction* showed that the grades varied overall. A Scheffe post-hoc test revealed significant differences in skill gain between grade 3 and grade 6 ($p = 0.024$) and between grade 3 and grade 6 ($p = 0.04$).

Analysis of the results of the workshop, based on surveys for competency *C5: The skill of using spatial elements and light in modelling,* is shown in Table 7.

Table 7: Means and standard deviations for competency C5.

Grade	M		SD		N
	Before	After	Before	After	
3	1.47	3.40	0.91	1.35	15
6	2.25	3.92	1.39	0.77	24
8	4.23	4.96	0.86	0.84	22
Overall	2.78	4.17	1.58	1.14	61

A two-way ANOVA with repeated measures revealed statistically significant ($p = 0.007$) changes of each group of students in their skill gain after the workshop. These changes are estimated as strong with $\eta^2 = 0.16$. Testing of between-subject effects confirmed skill acquisition in all groups of students.

A Games-Howell post-hoc test was applied to reveal differences between groups of students where equal variances are not assumed. This test revealed significant differences between grade 3 and grade 8 ($p = 0.006$) and grade 6 and grade 8 ($p = 0.034$). Skill acquisition by students of grade 3 and grade 6 were comparable ($p > 0.05$).

Analysis of the results of the workshop, based on surveys for competency *C6: The skill of working in a team,* is shown in Table 8.

Table 8: Means and standard deviations for competency C6.

Grade	M		SD		N
	Before	After	Before	After	
3	4.27	5.40	0.96	0.73	15
6	5.34	5.46	0.56	0.59	24
8	5.35	5.37	1.01	0.72	22
Overall	5.08	5.40	0.95	0.67	61

Team-working is an important skill which enables team-learning in architectural education. A two-way ANOVA with repeated measures revealed significant differences in skill acquisition across the groups of students (F = 7.24, p = 0.002). Overall, the workshop had some effects on skill acquisition (p = 0.013) with an effect size of η^2 = 014.

A Scheffe post-hoc test revealed some difference in favour of grade 3 against grade 6 (p = 0.008) and grade 8 (p = 0.003). No differences were found on teamwork skill acquisition for students of grades 6 and 8.

Mean differences of skill gain, $Mean_{post\text{-}test}$ - $Mean_{pre\text{-}test}$, were calculated and a multivariate analysis of skill gain was performed for each competency (C1-C6) as dependent variables. This confirmed statistically significant differences in group learning and skill acquisition for C3, C4, C5 and C6 ($p < 0.05$), as shown in Figure 1.

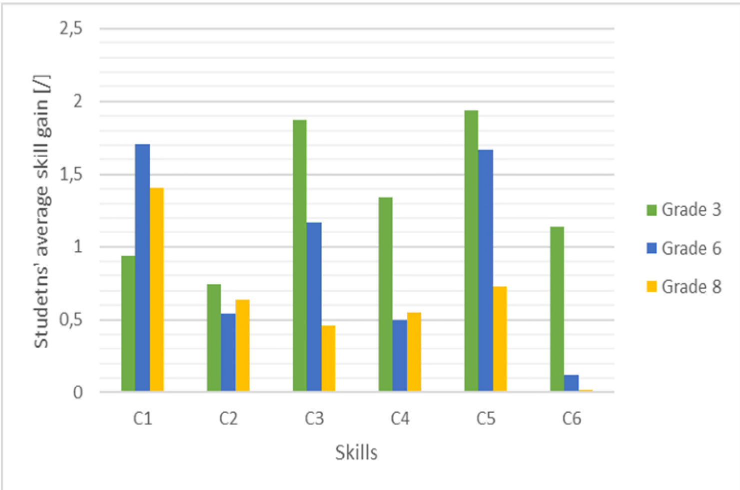

Figure 1: Students' gain in competencies C1- C6 by grade.

The research team also sought to answer the second question of the research, i.e. whether there are gender differences. Using a skill gain for each of the competencies (C1-6) revealed no significant gender differences in any of the observed competencies (see Figure 2).

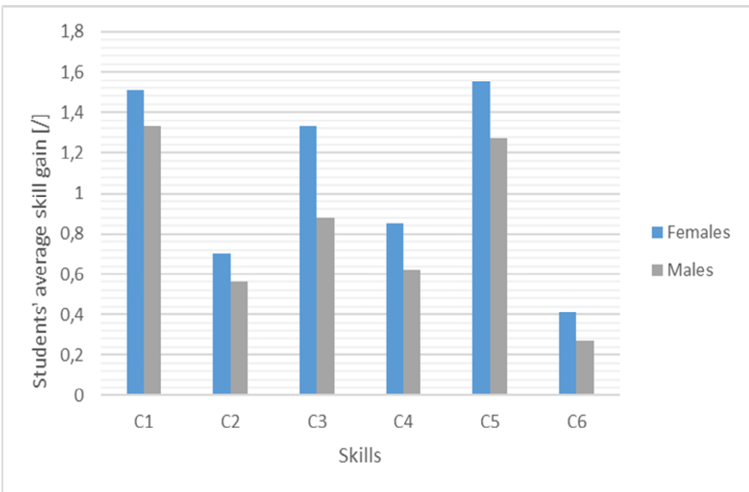

Figure 2: Students' gain for each competency C1- C6, by gender.

Differences in skill gain by gender are caused by *other influencers*. At competency C3, which presents situation awareness, female students perceived stability of structural elements higher than did their male counterparts (competency C3). With a risk less than 16%, this difference could be significant.

CONCLUSIONS

In summary, the workshop contributed to increased competencies of children and youths in terms of familiarity with the matter associated with the *We Build* module of the Young Architects programme. The greatest gain in competence was observed in the youngest children, aged eight to 10. This can be associated with the attractiveness of the classes for this group. These were based on play, which generated very high interest in young children who were not *bored* as observed with teenagers. However, competencies increased in the other age groups as well, although to a lesser degree. Sometimes this was a result of greater awareness of the subject before the workshop.

The proposed model in this study was gender-neutral. Thus, early architecture education should apply equally to female and male students. The model offers a way for students to locate and filter information. Further, they can develop their knowledge through active learning. Hence, students can become more aware of their natural and built environments.

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