

A comparative study of non-digital green skills among students in Bulgaria and Romania

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Abstract. *The transition towards a green economy requires a workforce equipped not only with technical expertise but also with strong transversal, non-digital competences that enable adaptation, collaboration, and innovation in dynamic work environments. This study contributes to the ongoing debate on the definition and measurement of “green skills” by focusing on their non-digital dimensions – learning autonomy, teamwork, communication, creativity, analytical reasoning, and problem-solving. The research employs an inductive and empirical-comparative approach within the framework of the Erasmus+ project Educate4Green, analysing students’ self-assessment of these competences at two higher education institutions: the University of Ruse “Angel Kanchev” (Bulgaria) and the National University of Science and Technology POLITEHNICA Bucharest (Romania). The results provide novel empirical evidence on regional patterns of green readiness among students in higher education institutions across Southeast Europe. Findings indicate that Bulgarian students demonstrate higher autonomy and analytical awareness, while Romanian students show stronger teamwork and communication skills. These competences form the socio-intellectual foundation of the green transition, as they directly support learning adaptability, collaborative problem-solving, and the implementation of sustainable practices in future workplaces. The study offers a theoretically grounded and practically relevant contribution by empirically operationalising non-digital green skills, providing insights for curriculum development and policy planning to strengthen human capital for the green transition.*

Keywords: non-digital green skills, green transition, transversal competences, higher education, sustainable workforce

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Introduction

The green transition (GT) represents one of the most transformative processes shaping the global labour market. The increasing adoption of environmentally sustainable technologies and practices is creating new professions, while simultaneously redefining existing ones [1]. Forecasts by the International Energy Agency suggest that this transition could generate millions of new jobs and contribute to a 3.5% growth in global GDP [2]. However, the rapid pace of technological and ecological change risks creating skill mismatches if education systems fail to adapt to emerging labour-market needs [1,3].

In this context, *green skills* (GSs) have become a widely discussed but still conceptually ambiguous term. They are often used interchangeably with *green jobs* or associated exclusively with technical expertise, which makes their practical application difficult [4-6]. The lack of a unified definition results in fragmented research approaches –

many studies analyse sectoral or macroeconomic aspects of the green economy, but few explore how these skills manifest at the individual level among future professionals.

The present study contributes to addressing this gap by operationalising the non-digital, transversal dimension of GSs – *learning autonomy, analytical and problem-solving abilities, teamwork, communication, and conflict resolution*. These socio-intellectual competences are considered a critical enabler of the GT, as they allow individuals to transform environmental knowledge into practical, sustainable action [5,7,8]. In doing so, the paper moves beyond the definitional ambiguity surrounding GSs and provides a replicable empirical framework for their assessment in higher education.

Unlike prior studies that focus primarily on technical qualifications or environmental awareness, this research isolates the non-digital components of GSs. It applies a cross-national comparative approach between two higher education institutions in Southeast Europe – the *University of Ruse “Angel Kanchev” (Bulgaria)* and the *National University of Science and Technology POLITEHNICA Bucharest (Romania)*. This regional focus provides novel empirical data on student preparedness for the GT, complementing the broader European and international research landscape. Thus, the paper contributes scientific value on two levels: conceptually – by refining the understanding of non-digital GSs through empirical operationalisation; and practically – by offering evidence-based insights to guide curriculum design and educational policy in support of a sustainable, adaptable workforce. The objectives of the study are as follows: (1) To establish how students self-assess their autonomy in learning and readiness for independent work; (2) To analyse the extent to which students demonstrate an orientation towards teamwork and cooperation; (3) To assess the level of communication skills, expressed through mutual respect and transparency in communication; (4) To examine how students perceive their ability to find solutions when problems arise; and (5) To compare the results between the two universities to identify common trends, differences, and areas for further development.

The paper is organised as follows: Section 2 presents the theoretical background and reviews the relevant literature; Section 3 outlines the methodology and data collection process; Section 4 reports the empirical findings and provides a discussion; and finally, Section 5 summarises the conclusions and provides recommendations for future practice.

Theoretical background

The transition towards a green economy has become an imperative for both developed and developing countries, driven by the urgent need to mitigate environmental degradation and promote sustainable growth. Rapid technological innovation and declining costs of renewable solutions have accelerated the adoption of green technologies across sectors, driving structural changes in production, consumption, and employment [4]. This shift does not merely require new technical qualifications; it also transforms the profile of competences demanded on the labour market.

Recent economic and policy research highlights that the GT is simultaneously a technological and human transformation. While traditional skill frameworks emphasise sector-specific expertise, the emerging green economy increasingly values transversal and adaptive skills, which enable continuous learning and problem-solving in complex, interdisciplinary contexts [1,3,5]. In this sense, the development of GSs – understood as the knowledge, abilities, and attitudes that support environmentally responsible work and sustainable production – has become a central component of modern human capital strategies [2,6].

However, the concept of GSs remains poorly defined in both academic and policy discourse. Many studies associate them primarily with technical abilities (such as renewable energy management or carbon accounting), while others include social and cognitive dimensions but without clear operationalisation [4,6]. CEDEFOP (European Centre for the Development of Vocational Training) and the International Labour Organisation (ILO) [5] propose a broader view, describing GSs as a combination of technical, cognitive, and socio-emotional competences that enable individuals to apply sustainability principles in real-life contexts. In addition, the notion of skill complementarities advanced in future-skills research indicates that the value of one competence (e.g., environmental technical knowledge) is significantly enhanced when paired with complementary skills such as judgment, idea fluency, and analytical thinking [7]. This multidimensional perspective provides the theoretical basis for the present study.

Within this framework, non-digital, transversal competences – such as learning autonomy, communication, teamwork, creativity, and problem-solving – are seen as the enabling layer of the GT. They do not replace technical skills but enable individuals to adapt and innovate in rapidly changing environments. Empirical evidence supports this interpretation: Bakhshi *et al.* [7] identify adaptability, communication, and creativity as essential to sustainable employment in the context of Industry 5.0, while Poláková *et al.* [8] emphasise the growing importance of emotional

intelligence, resilience, empathy, creativity and critical thinking as essential qualities for a future, competent and productive workforce.

The findings of Bakhshi *et al.* [7] suggest that future labour markets will increasingly reward interpersonal, higher-order cognitive, and systems skills. In this view, the transversal competences (communication, critical thinking, systemic understanding) defined by authors are not optional add-ons but essential complements to technical expertise. Similarly, Akinsemolu and Onyeaka [9] and OECD (Organisation for Economic Co-operation and Development) [10] underline that education for sustainable development must cultivate both technical and socio-intellectual capacities to achieve meaningful progress toward green growth.

The theoretical foundation of this study, therefore, lies at the intersection of GT studies with competence-based education. It assumes that GSs can be empirically captured through measurable behavioural indicators corresponding to transversal, non-digital competences. These competences serve as proxies for an individual's readiness to engage in sustainable professional practices – learning to learn, teamwork, communication, and problem-solving – identified in previous research as central to the human dimension of sustainability [5,7,11]. By adopting this approach, the current research addresses two theoretical gaps. First, it clarifies the conceptual boundaries of GSs by offering an operational definition grounded in socio-intellectual competences. Second, it provides an empirical framework for comparing the level of these skills among students in Bulgaria and Romania, thus adding novel regional evidence to the literature. In doing so, the study positions itself within the broader European discourse on building a skilled, adaptable workforce capable of supporting the ongoing GT.

Methodology

The methodology of this study was developed within the framework of the Educate4Green project, co-financed by the Erasmus+ programme. The project partners are: *National University of Science and Technology POLITEHNICA Bucharest*, Romania; *Eurotraining Solution SRL*, Bucharest, Romania; *SC INFORELEA*, San Secondo di Pinerolo, Italy; *Politechnika Łódzka University of Technology*, Łódź, Poland; and *University of Ruse Angel Kanchev*, Bulgaria. The primary objective of the project is to assess the current developments towards the GT, focusing on environmental responsibility, its impact on business and employment, as well as identifying training needs for developing green and ecological skills among students and practitioners in higher education.

In defining the methodological framework, this study applies an empirical–comparative approach embedded in the broader context of the European Green Transition. The research is grounded in the understanding that the GT – as a practical implementation of sustainability principles – requires not only technical expertise but also transversal, non-digital competences that enable individuals to adapt, collaborate, and innovate in changing work environments.

The questionnaire items presented in Table 1 operationalise these competences as measurable indicators of *green readiness*. They are derived from the CEDEFOP and ILO definitions of GSs, which conceptualise them as a combination of knowledge, abilities, values, and attitudes that support environmentally responsible behaviour and sustainable economic activity. Each thematic block of questions corresponds to a critical dimension of the human capital required for the GT: (1) *Learning autonomy* (Q1) refers to the ability to acquire and update knowledge independently, which is essential for reskilling and upskilling during the transition to greener industries; (2) *Analytical and problem-solving skills* (Q2–Q4) capture the cognitive capacities necessary for innovation, process optimisation, and adaptation to low-carbon production systems; (3) *Communication and teamwork* (Q5–Q6) emphasise the collaborative and interdisciplinary nature of sustainability transformations, where effective dialogue and cooperation are prerequisites for innovation and change management; (4) *Conflict resolution skills* (Q7) represent the social and ethical dimension of the GT, ensuring inclusivity, respect, and consensus in decision-making.

By linking these non-digital competences to the mechanisms of the GT, the study establishes a transparent analytical bridge between individual capacities and systemic sustainability objectives. Although the research is conceptually aligned with the Sustainable Development Goals (SDGs), its primary focus is on the regional and educational dimensions of the GT rather than on global policy frameworks. That ensures both scientific relevance and contextual precision, positioning the study within the ongoing European efforts to build a skilled, adaptable, and sustainability-oriented workforce.

The study was conducted using an electronic questionnaire, created in Google Forms and distributed through the email networks of the participating organisations and universities. The primary data were processed using Microsoft Excel software. The study aims to provide an up-to-date and timely analysis of local training needs related to green knowledge, green jobs and enterprises, as well as the expected skills of participants from the target groups: students, teachers and practitioners. The survey supports the articulation of demand for environmental skills. It analyses the transition to green transformation, emphasising the development of complex competences with

cognitive, socio-emotional, behavioural, and digital dimensions. The pilot study was conducted from *October to December 2023*.

Questionnaire structure

The questionnaire (Table 1) developed for the project covers four thematic sections: 1) Demographic profile; 2) Measurement of knowledge of green concepts / knowledge of green transformation; 3) Measurement of the level of GSs (intellectual and digital)/ respondents' opinions regarding their GSs – concept of green knowledge, GSs with non-digital components (intellectual and social), digital components (creative use of digital technologies); 4) Identification of training needs and expectations for greening of workplaces and enterprises / training expectations.

The survey employs a five-point Likert scale for self-assessment of competences, enabling respondents to evaluate the level of development of various skills. The levels of the scale range from 1 (*Highly developed*, indicating complete confidence in application) to 5 (*Not at all developed*, indicating a poorly defined or completely absent skill). This scale enables the quantitative measurement of students' subjective competence and facilitates comparative analysis among different groups. The “*Do not know*” category (3) provides additional information about uncertainty or lack of experience in specific competences, which is helpful for data interpretation and for identifying areas for targeted training.

Table 1: Questions (statements) within the scope of the current study.

Competence Dimension	
Learning to learn	Q1.1. They are able to organise their own learning autonomously.
	Q1.2. They know and understand their preferred learning strategies.
Analytical skills	Q2.1. They select sources directly related to key concepts or to the research question.
	Q2.2. They can analyse, synthesise and evaluate the quality of information.
Creativity & innovation	Q3.1. They can transform ideas or solutions into entirely new forms.
	Q3.2. They can respond creatively to problems and opportunities.
Problem-solving	Q4.1. They can identify and analyse problems in difficult situations and make a justifiable evaluation.
	Q4.2. They can look for the causes of problems so that they can understand what's really going on.
Communication skills	Q5.1. They communicate transparently, stating clearly what they want to express.
	Q5.2. They consider cultural barriers when planning their communications.
Teamwork skills	Q6.1. They listen carefully to what the other team members have to say.
	Q6.2. They encourage quiet group members to contribute.
Conflict resolution skills	Q7.1. They treat their team members with respect.
	Q7.2. They welcome suggestions for improvements

Source: Author's development

Scope of the study

This paper covers the data from the target group of students from the National University of Science and Technology POLITEHNICA Bucharest (UPB) and the University of Ruse Angel Kanchev (URAK), focusing on the results of Section 3 of the questionnaire (*Measurement of non-digital GSs*). Although the overall project considers the perspectives of three groups of respondents (teachers, students, and practitioners), this analysis focuses exclusively on students. The project pre-determines the minimum number of respondents for UPB and URAK – 50 and 40 students, respectively - with these values being proportionally distributed between the partners and corresponding to the quantitative targets set in the Educate4Green framework.

Sample formation

The study included 126 students from UPB (N=83) and URAK (N=43). In UPB, the majority of respondents were bachelors in “*Business and Engineering*” (75%) and “*Business and Management*” (24%). In URAK, all participants were bachelor's degree holders, with the largest share coming from the “*Business and Management*” field (72%). In terms of gender, women comprised 54% of the population in UPB, while in URAK, they constituted 74%. The age structure was similar, with all respondents from UPB and 95% of those in URAK being aged 20-29, which is an indicator of relevant professional experience.

Results and further discussions

The results of the comparative analysis of the two groups of respondents from URAK and UPB universities (Table 2) show a clearly expressed positive trend in all considered competences. Regardless of the specific differences between the individual indicators, the general picture is that students from both institutions demonstrate well-developed skills in the areas of learning, analysis, creativity, problem-solving, communication, teamwork, and conflict resolution skills. The majority of respondents self-assess themselves in the “*Developed*” and “*Highly developed*” categories, which indicates a high level of subjective competence and confidence in their abilities.

Some differences are observed in *learning skills* (Q1.1/Q1.2). URAK students are more likely to place themselves in the highest “*Highly developed*” category when organising their own learning (40% compared to 28% for UPB). In comparison, UPB shows a higher share in the “*Developed*” category (46% compared to 35%). This finding aligns with research indicating that learning autonomy is linked to improved academic performance and motivation [7]. A similar picture emerges in the knowledge of preferred learning strategies, where URAK has more respondents with the highest score (44% vs. 31%). This suggests that although students at both universities demonstrate robust autonomy, URAK seems to place a stronger emphasis on self-organisation and awareness of learning approaches. *Analytical skills* (Q2.1/Q2.2) are also clearly developed. When selecting appropriate sources, URAK students more often define their skills as “*Highly developed*” (33% vs. 29% for UPB), while UPB students more often choose the intermediate level “*Developed*” (49% vs. 44%). In analysing and synthesising, both groups showed almost identical levels of competence. Therefore, despite slight differences in the distribution by category, both groups achieved a high level of analytical maturity, which in turn confirms the results of studies highlighting the importance of analytical skills for academic success [12].

Table 2: Non-digital green skills in relation to what is required on the job market: Comparison between URAK (N=43) & UPB (N=83).

	1 - <i>Highly developed</i>				2 - <i>Developed</i>				3 - <i>Do not know</i>				4 - <i>Somehow developed</i>				5 - <i>Not at all developed</i>			
	URAK		UPB		URAK		UPB		URAK		UPB		URAK		UPB		URAK		UPB	
Q	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1.1	17	40%	23	28%	15	35%	38	46%	6	14%	16	19%	4	9%	6	7%	1	2%	0	0%
1.2	19	44%	26	31%	19	44%	39	47%	3	7%	7	8%	2	5%	9	11%	0	0%	2	2%
2.1	14	33%	24	29%	19	44%	41	49%	8	19%	11	13%	2	5%	6	7%	0	0%	1	1%
2.2	16	37%	27	33%	21	49%	36	43%	5	12%	12	14%	1	2%	8	10%	0	0%	0	0%
3.1	12	28%	17	20%	23	53%	42	51%	6	14%	15	18%	2	5%	7	8%	0	0%	2	2%
3.2	16	37%	31	37%	18	42%	34	41%	7	16%	6	7%	2	5%	10	12%	0	0%	2	2%
4.1	16	37%	32	39%	22	51%	38	46%	5	12%	6	7%	0	0%	6	7%	0	0%	1	1%
4.2	21	49%	34	41%	16	37%	32	39%	5	12%	11	13%	1	2%	5	6%	0	0%	1	1%
5.1	14	33%	29	35%	17	40%	35	42%	11	26%	7	8%	1	2%	10	12%	0	0%	2	2%
5.2	13	30%	20	24%	22	51%	32	39%	5	12%	17	20%	3	7%	9	11%	0	0%	5	6%
6.1	18	42%	38	46%	20	47%	33	40%	5	12%	5	6%	0	0%	6	7%	0	0%	1	1%
6.2	13	30%	35	42%	23	53%	33	40%	6	14%	8	10%	1	2%	5	6%	0	0%	2	2%
7.1	19	44%	49	59%	20	47%	28	34%	4	9%	5	6%	0	0%	1	1%	0	0%	0	0%
7.2	19	44%	38	46%	19	44%	36	43%	5	12%	7	8%	0	0%	1	1%	0	0%	1	1%

Source: Author's development

In terms of *creativity and innovation* (Q3.1/Q3.2), the profiles of the two universities are remarkably similar. URAK demonstrates a slight advantage in transforming ideas into new forms, with 28% answering “*Highly developed*” compared to 20% for UPB. In *creative problem solving*, the distributions in both groups are almost identical, with 37% self-assessing themselves as “*highly developed*.” This result indicates a developed ability to generate solutions in both samples, which is consistent with research highlighting the key role of creativity for innovation in education [13].

In the area of *problem solving* (Q4.1/Q4.2), the similarity is even more pronounced. In identifying and analysing problems, 37% of URAK and 39% of UPB define themselves as “*Highly developed*”, while the rest are predominantly classified as “*Developed*”. This confirms the results of studies that emphasise the importance of problem-solving skills for academic success [14]. In the search for causes of problems, URAK shows a higher share in the highest category (49% vs. 41%), but this difference is not significant. These results highlight the robust problem-solving abilities in both groups. *Communication skills* (Q5.1/Q5.2) show interesting differences. In transparent communication, UPB slightly outperforms URAK in the share of “*Highly developed*” (35% vs. 33%),

whereas considering cultural barriers, URAK is ahead (30% vs. 24%). These data suggest that students develop different aspects of communicative competence, with some focusing on clarity and others on cultural sensitivity. This finding is consistent with research that emphasises the importance of effective communication skills for successful teamwork and conflict resolution [15].

Both groups highly rate *teamwork* (Q6.1/Q6.2). In active listening, URAK and UPB have similar profiles, with a slight advantage for UPB in the highest category (46% vs. 42%). A more pronounced difference is seen in the promotion of quiet group members, where UPB shows 42% “*Highly developed*” versus 30% for URAK. This can be interpreted as a tendency for UPB students to demonstrate a greater willingness to engage all team members. At the same time, in URAK, the emphasis falls on other aspects of teamwork. This confirms the results of studies that highlight the importance of teamwork in developing social and communication skills [16]. *Conflict management* (Q7.1/Q7.2) is an area in which UPB stands out more clearly. In respect for colleagues, 59% of UPB students choose “*Highly developed*” versus 44% of URAK. A similar advantage is maintained in the acceptance of suggestions for improvements, although the difference is minor (46% vs. 44%). The results suggest that there is a stronger culture of mutual respect and acceptance of feedback in the UPB environment, which is consistent with research on effective teamwork and positive learning environments [17].

In summary, the results confirm that students at both universities demonstrate high levels of development of the skills considered. URAK is distinguished by a greater concentration of respondents in the highest categories for learning skills, analysis, and cultural sensitivity. At the same time, UPB shows an advantage in teamwork, respect, and transparent communication. In general, both groups demonstrate a firm profile of personal and professional development. For future practices, it would be beneficial to leverage the strengths of each institution through the exchange of experiences – for example, URAK could share its expertise in autonomous learning. At the same time, UPB could offer best practices in teamwork and respectful behaviour. Research indicates that inter-university exchanges can enhance academic performance and promote innovation in learning [18]. Additional attention could be paid to cases where students choose “*Do not know*”, as this could signal a lack of confidence or experience in certain situations. Encouraging reflective practices and sharing experiences can reduce uncertainty and increase overall competence, as reflective learning is a proven approach to promote self-awareness and critical thinking [19].

The comparative analysis confirms that non-digital GSs constitute a measurable and meaningful dimension of students’ preparedness for the GT. The observed differences between the two institutions – higher learning autonomy among Bulgarian students and stronger teamwork and communication among Romanian students – reflect distinct educational cultures and pedagogical emphases. These findings empirically validate the theoretical assumption that transversal, socio-intellectual competences are essential enablers of sustainable behaviour and adaptability in the context of the green economy. They also reinforce the notion, articulated in CEDEFOP and OECD frameworks [4,10], that GT readiness depends not only on technical knowledge but also on the capacity for collaboration, innovation, and lifelong learning. Consequently, the results support the conceptual approach adopted in this study, demonstrating that operationalising GSs through non-digital competences provides a valid and replicable model for assessing human capital development in higher education.

Limitations of the study

The present study has several significant limitations that should be considered when interpreting the results. First, the data are based on student self-assessment, which implies a particular subjectivity and risk of socially desirable responses. This can lead to both overestimation and underestimation of the skills actually possessed. Second, the tool includes a “*Do not know*” category; however, the high percentage of respondents choosing this answer suggests some uncertainty or lack of experience in certain areas. The lack of in-depth, qualitative explanations from respondents does not allow for a more precise interpretation of the reasons behind these answers. Third, the study was conducted within specific university environments and on groups of limited size, which limits the possibility of generalising the results to broader student populations. Finally, the study employs a cross-sectional design, which limits its ability to provide information on the development of competences over time or to establish cause-and-effect relationships.

Practical applicability

Despite these limitations, the study’s results have high practical value for university practice and the management of educational programs. First, they allow the managements of both institutions to identify the strengths of their students – for example, the higher autonomy at URAK and the more pronounced teamwork at UPB. This can serve as a basis for exchanging good practices and for joint initiatives aimed at developing a more balanced skill profile. Second, the data indicate specific areas where additional attention is needed – such as the communicative aspects at URAK or autonomous learning at UPB. It is recommended to integrate targeted training, coaching or project-based

tasks into the learning process to strengthen these competences. Third, the presence of a particular share of “*Do not know*” answers emphasises the need to introduce reflective practices and systematic feedback to help students become aware of and articulate their own strengths and weaknesses. More broadly, the results can support the strategic planning of academic programs so that they meet not only theoretical requirements but also the practical expectations of the modern labour market, where learning, teamwork, communication, and problem-solving skills are considered key factors for professional success.

Conclusion

The present study provides an original empirical contribution to the growing body of research on the human dimension of the GT. By focusing on the non-digital, transversal elements of GSs – learning autonomy, teamwork, communication, creativity, and problem-solving – it offers a practical model for operationalising a concept that remains theoretically underdefined in current literature. The comparative analysis between students from the University of Ruse “Angel Kanchev” (Bulgaria) and the National University of Science and Technology POLITEHNICA Bucharest (Romania) reveals distinct strengths in each academic context, demonstrating how different pedagogical approaches can shape green readiness.

The scientific value of this research lies in addressing the definitional gap surrounding GSs. While most studies discuss them in abstract or technical terms, the current work provides an empirical pathway for measurement through observable socio-intellectual competences. In this framework, GSs are not identical to non-digital skills. Still, they are expressed through them: teamwork, communication, and problem-solving become the mechanisms that enable the translation of environmental knowledge and values into sustainable professional practice. For instance, the ability to collaborate effectively in multidisciplinary teams, to communicate transparently across cultural and professional contexts, or to apply creative problem-solving in resource-efficient processes – all represent concrete manifestations of GSs in action.

At the same time, the research acknowledges its limitations. The conceptual ambiguity surrounding the term GSs inevitably constrains the precision of measurement and interpretation. Furthermore, the study’s reliance on self-assessment, its limited sample size, and its focus on two universities restrict the generalisability of the results. Nevertheless, these constraints highlight rather than weaken the study’s contribution: they underscore the urgent need for further theoretical clarification and methodological refinement in defining and assessing the competences that underpin the GT.

In conclusion, this paper contributes both conceptually and empirically to the understanding of GSs by offering a replicable approach to their operationalisation through non-digital competences. The findings support the argument that building a sustainable, adaptable workforce requires integrating transversal socio-intellectual skills into higher education curricula – thus bridging the gap between educational outcomes, labour market expectations, and the broader objectives of the GT.

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