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LEARNING POTENTIAL IN THE SOCIAL NETWORK-BASED EDUCATION (SNE) IN ENGINEERING: COMPARISON WITH TRADITIONAL PROJECT-LED EDUCATION

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Abstract: *This paper presents an analysis of the learning potential in Social Network-based Education (SNE) versus Project-Led Education (PLE). Analysis is based on data collected through the questionaires responded by students over twelve years of implementation of SNE. The results show that students generally perceived SNE as offering greater learning potential than classical PLE. The preference for SNE was also associated with higher perceived learning and with reported gains in personal growth and entrepreneurship. In this way, introduction of SNE, as an alternative educational methodology, is justified.*

Keywords: *social network-based education, project-led education, engineering education, learning.*

1. Introduction

Traditional models of engineering education are still based on foundational basis, but there is increasing interdisciplinarity and project-based learning based on real-world problems (Hsu et al., 2025), which could be interpreted as Education 2.0 education paradigm (Abidoye et al. 2024; Gerstein, 2014; Putnik et al., 2022).

Advances in science, technology, society and economy, especially in the context of industry 4.0 (I4.0), are shaping the engineering education. Also, quality in Higher Education (HE) could be promoted by online learning resources (Fahrurrozi et al., 2021; Vodenko & Latsveeva, 2023), e-learning environments (Stefanovic et al., 2007), or integrated learning strategies (Dyason, 2022).

So, Higer Education Institutions (HEI) should adapt to these emerging technological and social demand by integrating innovative methodologies (Pedrosa et al., 2025). This leads to the development and exploration of different educational models in engineeting education for teaching and learning. Fostering this development, OECD Learning Framework 2030 presents co-created *"design principles" for changes in curricula and education systems*" (OECD, 2018), in which some of them aligned with Education 3.0 paradigm (the authors does not consider Education 4.0 as a new paradigm but as a neoplasm of I4.0, see e.g. Putnik & Alves (2022). Social Network-Based Education education methodology as a "manifesto" of Education 3.0 (Putnik et al., 2015), is also aligned with the vision of OECD (2018).

In the context of this paper, the Social Network-Based Education (SNE) and the Project-Led Education (PLE) are two educational models in engineering, and as consequence the learning potential could be perceived differently among the students.

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This paper aims to evaluate the perception of the learning potencial of the SNE in engineering when compared with classical PLE, by students, over data from twelve years of implementation of SNE.

The research methodology in this paper was based on a survey conducted over twelve academic years, in which a structured questionnaire was sent to students each year. This long-term approach ensured robust data collection for hypothesis validation.

The paper is futher structured as follows. Chapter 2 and Chapter 3 presents the concept and approaches to SNE and PLE respectively. Chapter 4 describes the hypotheses related to learning potencial in SNE versus classical PLE, for validation. The experiment design and the main results are presented in Chapter 5 and Chapter 6, respectively. Chapter 7 highlights the results of this experiment. The paper finishes with the conclusion in Chapter 8, and references.

2. Social Networked-based Education

Social network is defined as "*a finite set or sets of actors and the relation or relations defined on them" where the actor can be "discrete individual, corporate, or collective social units*", and "*refers to the set of actors and the ties among them*" (Wasserman & Faust, 1994).

Social network in education is widely viewed as the use of tools to support education. Mera & Martínez (2024) present the impact of social networks on higher education. Doğan et al. (2018) refer to social networked-based education as the application of social networking platforms such as Edmodo (platform already closed) for teaching and learning activities. Hung & Yuen (2010) investigated the social networking platforms as supplement to traditional classes using sharing feature of the platform Ning. Correcher et al. (2024) pushed students using social network platforms to share student's practical work and to learn from other student's experience. Correcher et al. (2024) pushed students using social network platforms to share student's practical work and to learn from other student's experience.

Omidi et al. (2020) experiment uses SNE is an educational intervention delivered exclusively via a social network (Telegram^{TM}) channel, using scheduled posts and all the educational content was delivered exclusively by TelegramTM channel.

Considering the definition of social network by Wasserman & Faust (1994), and excluding the context of use of social network platforms, Putnik et al. (2016) originally developed, and implemented in engineering course, the SNE methodology with features of Education 3.0, in which the learning methodology is organized as a social network, where students and teachers form an interconnected network whose social structures, communication, and interaction shape the act of learning itself, where the projects based on social networks foster agility and self-organization (Putnik, Costa, Alves, Manupati, et al., 2016).

In SNE, the learning potencial is fostered by experiential learning, where the "learning path" is the "project first, just in time principles (Alves & Putnik, 2019), where the use of co-creation learning materials, enhance the "just in time principle", as the student's needs are replied in "real time" in a continuously update by professors and other students (Putnik & Alves, 2019).

SNE could be considered an extension of PLE (Putnik, Costa, Alves, Castro, et al., 2016; Putnik, Costa, Alves, Manupati, et al., 2016). While traditional PLE relies on fixed groups and predetermined tasks, SNE offers a more flexible approach, incorporating elements of Education 3.0 such as openness, collaboration, and the co-creation of knowledge. In this sense, when referring to the traditional model, we will use the term classical PLE to distinguish it from SNE.

3. Project-Led Education (PLE)

Project-Led Education (PLE) is designed to enhance student engagement and academic achievement (Powell, 2004). PLE is defined by Powell et al. (2003) (cited by Lima et al. (2007)) as a "team-*based student activity related to learning and to solving large-scale open ended projects*" where the "*team of students tackles the project, provides a solution, and delivers by an agreed delivery time (a deadline) a 'team product', such as a prototype and a team report. Students show what they have learnt by discussing with staff the 'team product'and reflecting on how they have achieved it*".

In PLE the professor (tutor) role is to guide the process of learning and not supply any solution for the project (Powell, 2004). This is typical application of Vygotsky's learning paradigm, through the model of "proximity zone" (Kozulin et al., 2003).

Implementing PLE has improved student's motivation and learning outcomes in engineering courses. However, teachers report an increased workload and the need for careful rubric and milestone design (Ruiz-Ortega et al., 2019). Additionally, implementing PLE, in some cases, can result in increased interdisciplinarity, as well as the development of communication and teamwork skills, which are recognised by both students and staff. However, it can also result in issues such as poor coordination between courses, excessive staff workload, and a lack of clear assessment criteria (Lima et al., 2007). Fernandes et al. (2014) also highlighted the students set of difficulties related to PLE, identifying "*the heavy workload which the project entails as one of the main constraints of this approach to learning*".

4. Hypotheses related to the learning potencial in SNE vs classical PLE

The hypotheses presented in this chapter are directly connected to the perception of the learning potencial of SNE versus the classical PLE by students. It is expected that with the introduction of SNE, students' perception of learning potencial in SNE is higher than in classical PLE.

The following hypotheses were formulated:

H1. Previous experience in PLE is positively associated with perceiving the SNE as better than traditional.

H2. Preference for working individually negatively correlates with preference for working in groups and mixed mode.

H3. Perceived greater learning in individual work is associated with preference for individual work.

H4. Perceived greater learning in group work is associated with preference for group work.

H5. Perceived greater learning in mixed work is associated with preference for mixed work.

H6. Preference for traditional theoretical/practical classes is negatively associated with preference for PLE and SNE.

H7. Preference for SNE positively associates with perceiving better learning with SNE than traditional PLE.

H8. Students who perceive SNE method as providing better learning also perceive it contributes more to inner growth and entrepreneurship.

H9. Previous PLE experience positively influences perception of SNE benefits for inner growth and entrepreneurship.

H10. Preference for SNE positively associates with perceiving better learning and better future skills contribution.

The hypotheses will be validated throught a questionnaire provided along the twelve scholar years, as explained in Chapter 5.

5. Experiment Design

SNE has been applied for thirteen years to the course of Integraded Master and Master of Industrial Engineering and Management, at the Department of Production and Systems Engineering, at the University of Minho. Almost all students had previous experience with classical PLE (from 435 students in total along twelve years, only18 had no previous experience with classical PLE).

A structured questionnaire was sent annually from 2012–2013 to 2024–2025 scholar years, with no data collected in 2021–2022. Therefore, the dataset comprises responses from twelve academic years. In total, 435 valid questionnaire responses were collected over these twelve years.

The questionnaire has a total of 22 questions, from which a subset of 14 questions was considered the most relevant to the context of this paper.

The 14 selected questions are:

Q1. Experience in previous PLE.

Q2. This type of working method is better than the traditional one.

Q3. It is preferable to work only individually, rather than only in a group, or in a mixed regime. (group and individually).

Q4. It is preferable to work only in groups, rather than only individually, or in a mixed regime (group and individually).

Q5. It is preferable to work in a mixed regime (group and individually), rather than only individually or only in groups.

Q6. Traditional theoretical and practical classes are preferable to theoretical classes and PLE in fixed groups or PLE through work by services/social networks/crowdsourcing

Q7. Theoretical classes and PLE in fixed groups are preferable to traditional theoretical and practical classes or PLE through work by services/social networks/crowdsourcing

Q8. It is preferable to have PLE by work by services/social network/crowdsourcing than traditional theoretical and practical classes or theoretical classes and PLE by fixed groups

Q9. The working method based on services/social network/crowdsourcing provides greater learning than the traditional PLE method

Q10. There is greater learning in working individually than in groups or in a mixed regime (group and individually)

Q11. There is greater learning in working in groups than individually or in a mixed regime (group and individually)

Q12. There is greater learning in working in a mixed regime (group and individually) than only individually or only in a group

Q13. The service/social network/crowdsourcing-based working method contributes to internal growth in adapting to uncertainties for your future as engineers

Q14. The service/social network/crowdsourcing-based working method contributes to entrepreneurship

Question Q1 has possible responses: “Yes” or “No”. Questions Q2 to Q14 were measured on a five-point Likert scale: 1 - Completely disagree, 2 - Partially disagree, 3 - Indifferent, 4 - Partially agree, 5 - Completely agree.

6. Results

The descriptive statistics for all questionnaire selected questions (Q1 to Q14) are presented in Table 1, for the sample (N) of 435 participants.

To test whether all questionnaire selected questions (Q1-Q14) distributed normally, it was conducted the Kolmogorov–Smirnov and Shapiro–Wilk tests (Table 2).

Both tests were highly significant for all input variables: $p < 0.001$; meaning the data is far from being distributed normally.

These results support the non-Gaussian distribution of the data and, thus we proceeded further with Spearman’s ρ to perform correlation analyzes.

Table 1. Descritpive statistics

Descriptive Statistics (N=435)				
	Min.	Max.	Mean	Std. Deviation
Q1	0	1	0,96	0,199
Q2	0	5	3,62	1,014
Q3	0	5	2,25	1,164
Q4	0	5	2,69	1,215
Q5	0	5	3,87	1,269
Q6	1	5	2,22	1,040
Q7	1	5	2,95	1,121
Q8	1	5	3,35	1,102
Q9	1	5	3,14	1,046
Q10	1	5	2,34	1,105
Q11	1	5	2,61	1,060
Q12	1	5	3,85	0,941
Q13	1	5	3,74	0,858
Q14	1	5	3,70	0,992

Therefore, a Spearman correlation analysis was conducted to test hypotheses H1–H10 (Table 3), exploring the relationships between preferences, perceived learning, and perceived contribution to future skills, in SNE, comparing with classical PLE, in engineering.

For each hypothesis, the mains results are described as follows.

H1. Previous experience in PLE (Q1) is positively associated with perceiving the SNE as better than traditional (Q2)

Previous PLE experience (Q1) showed **negligible relationship** with perceiving SNE as better than the traditional method (Q2), $\rho = 0.016$, p-value = 0.734. **The hypothesis was not validated.**

Table 2. Kolmogorov-Smirnov and Shapiro-Wilk Tests of Normality

Tests of Normality				
	Kolmogorov-Smirnov[a]		**Shapiro-Wilk**	
	Statistic (D)	**p-value**	**Statistic**	**p-value**
Q1	,541	<,001	,198	<,001
Q2	,344	<,001	,816	<,001
Q3	,243	<,001	,876	<,001
Q4	,208	<,001	,920	<,001
Q5	,255	<,001	,791	<,001
Q6	,247	<,001	,862	<,001
Q7	,203	<,001	,901	<,001
Q8	,257	<,001	,889	<,001
Q9	,214	<,001	,898	<,001
Q10	,270	<,001	,867	<,001
Q11	,245	<,001	,893	<,001
Q12	,279	<,001	,853	<,001
Q13	,306	<,001	,843	<,001
Q14	,261	<,001	,871	<,001
a. Lilliefors Significance Correction				

Table 3. Hypotheses H1 to H10 results using the Spearman correlation analysis

Hypotheses	Variables (Q)	Spearman's ρ	*p*-value	Hypotheses Validation
H1	Q1–Q2	0.016	0.734	Not validated
H2	Q3–Q4	0.121*	0.011	Partially validated
	Q3–Q5	−0.250**	<0.001	
	Q4–Q5	−0.135**	0.005	
H3	Q3–Q10	0.492**	<0.001	Validated
H4	Q4–Q11	0.445**	<0.001	Validated
H5	Q5–Q12	0.397**	<0.001	Validated
H6	Q6–Q7	0.205**	<0.001	Partially validated
	Q6–Q8	−0.272**	<0.001	
	Q7–Q8	−0.090	0.061	
H7	Q8–Q9	0.297**	<0.001	Validated
H8	Q9–Q13	0.422**	<0.001	Validated
	Q9–Q14	0.397**	<0.001	
H9	Q1–Q13	0.022	0.655	Not validated
	Q1–Q14	−0.001	0.985	
H10	Q8–Q9	0.297**	<0.001	Validated
	Q8–Q13	0.255**	<0.001	
	Q8–Q14	0.236**	<0.001	

Note: $p < 0.05$ (*), $p < 0.01$ (**)

H2. Preference for working individually (Q3) negatively correlates with preference for working in groups (Q4) and mixed mode (Q5).

Preference for individual work (Q3) showed a **weak negative relationship** with preference for mixed mode (Q5), $\rho = -0.250$, $p < 0.001$, and a **negligible negative relationship** with preference for group work (Q4), $\rho = -0.135$, $p = 0.005$. However, Q3 correlated negligible positive relationship with Q4, $\rho = 0.121$, $p = 0.011$. **Therefore, the hypothesis was only partially validated.**

H3. Perceived greater learning in individual work (Q10) is associated with preference for individual work (Q3).

Perceived greater learning in individual work (Q10) was **strongly positively related** to preference for individual work (Q3), $\rho = 0.492$, $p < 0.001$, **validating the hypothesis**.

H4. Perceived greater learning in group work (Q11) is associated with preference for group work (Q4).

Perceived greater learning in group work (Q11) strongly positively related with preference for group work (Q4), $\rho = 0.445$, $p < 0.001$, **validating the hypothesis**.

H5. Perceived greater learning in mixed work (Q12) is associated with preference for mixed work (Q5).

Perceived greater learning in mixed mode (Q12) was **moderately positively related** with preference for mixed mode (Q5), $\rho = 0.397$, $p < 0.001$, **validating the hypothesis**.

H6. Preference for traditional theoretical/practical classes (Q6) is negatively associated with preference for PLE (Q7) and SNE (Q8).

Preference for traditional theoretical/practical classes (Q6) showed a **weak negative relationship** with preference for SNE (Q8), $\rho = -0.272$, $p < 0.001$, consistent with the hypothesis.

However, Q6 correlated weak positive relationship with preference for PLE in fixed groups (Q7), $\rho = 0.205$, $p < 0.001$, and Q7 had a negligible negative relationship with Q8, $\rho = -0.090$, $p = 0.061$, partially contradicting expectations. **Thus, the hypothesis was partially validated.**

H7. Preference for SNE (Q8) positively associates with perceiving better learning with SNE than traditional PLE (Q9).

Preference for SNE (Q8) was **weak positive relationship** with perceiving greater learning with this method compared to traditional PLE (Q9), $\rho = 0.297$, $p < 0.001$, **validating the hypothesis**.

H8. Students who perceive SNE method as providing better learning (Q9) also perceive it contributes more to inner growth (Q13) and entrepreneurship (Q14).

Perceiving greater learning in SNE (Q9) was **strong positive relationship** with perceiving that this method contributes to inner growth (Q13), $\rho = 0.422$, $p < 0.001$, and a **moderate positive relationship** with entrepreneurship (Q14), $\rho = 0.397$, $p < 0.001$. These results strongly **validate the hypothesis**, indicating that students who report higher learning outcomes in SNE also recognise its benefits for personal development and entrepreneurial skills.

H9. Previous PLE experience (Q1) positively influences perception of SNE benefits for inner growth (Q13) and entrepreneurship (Q14).

Previous experience in PLE (Q1) showed **negligible relationship** with perceptions of the benefits of SNE for inner growth (Q13), $\rho = 0.022$, $p = 0.655$, and **negligible relationship** with entrepreneurship (Q14), $\rho = -0.001$, $p = 0.985$. Thus, the **hypothesis is not validated**, indicating that prior PLE experience does not significantly influence students' perceptions of SNE's contribution to personal development or entrepreneurial outcomes.

H10. Preference for SNE (Q8) positively associates with perceiving better learning (Q9) and better future skills contribution (Q13, Q14).

Preference for SNE (Q8) **weak positive relationship** with perceiving greater learning

(Q9), $\rho = 0.297$, $p < 0.001$, as well as a **weak positive relationship** with perceiving that SNE contributes to inner growth (Q13), $\rho = 0.255$, $p < 0.001$, and entrepreneurship (Q14), $\rho = 0.236$, $p < 0.001$. These findings **validated the hypothesis**, suggesting that students who prefer SNE also tend to perceive it as providing enhanced learning outcomes and fostering important future skills.

7. Discussion

The analysis of the ten hypotheses reveals that the SNE method is generally perceived as providing higher learning potential compared to the traditional PLE, while also offering added value in personal and professional skills development.

Hypotheses H7, H8, and H10 confirm that students who prefer the SNE method also report greater perceived learning outcomes compared to PLE (Q9), as well as higher contributions to inner growth (Q13) and entrepreneurship (Q14). These relationships ranged from *weak* to *moderate* in strength, yet were statistically significant, indicating that students consistently view SNE as more effective in promoting both academic achievement and skills relevant to engineering careers.

H8 shows that higher perceived learning in SNE correlates strongly with personal development dimensions, suggesting that SNE fosters soft skills alongside technical knowledge.

Comparing SNE with PLE, H1 and H9 demonstrate that previous experience in PLE does not significantly influence perceptions of SNE as a better method. This suggests that the perceived value of SNE is consistent among different student profiles, regardless of their familiarity with the traditional PLE.

In relation to the work preferences, H2, H3, H4, and H5 reveal alignment between students' preferred work formats (individual, group, mixed) and their perceptions of learning effectiveness in those formats. For example, students who prefer group work perceive greater learning in that mode, and the same applies to individual and mixed modes. However, H2 shows only partial confirmation of the expected negative relationship between individual and collaborative preferences — the data indicate that some students maintain flexibility, enjoying both individual and group work. This flexibility is relevant for SNE, which includes individual and collective (groups) tasks.

8. Conculsions

This study evaluated the learning potential in SNE compared with classical PLE. Over twelve academic years, students perceived SNE as offering greater learning potential than classical PLE. The preference for SNE was associated with higher perceived learning and with reported gains in personal growth and entrepreneurship.

These results justify the introduction of SNE as an additional teaching methodology in engineering courses. As it is the matter of methodology, it is expected that this is applicable to other type of courses.

Future work could address the following issues:

1. Higher involvement of companies as service clients and/or providers of real case tasks;
2. Development of models for collaborative work among the students themselves and among the students and companies.
3. Development of models for effective and efficient implementation of artificial intelligence/machine learning (AI/ML) techniques.
4. Contribution to the new institutional rules towards Education 3.0 paradigm shift.

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