Transferring Learning into the Workplace: Evaluating a Student-centered Learning Approach through Computer Science Students' Lens

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Abstract: Over time, instructional training activities for academics that promote student-centered learning (SCL) increased. However, few things are known about the extent to which academics' learning is transferred into the daily teaching practice. In this study, we investigated the impact of transferring learning into the workplace of an Informatics teacher (first author of this paper) seeking to promote SCL within a new discipline in her portfolio (i.e., *Software Engineering*). For this purpose, a quasi-experimental design with pre- and post-test was employed. Self-reported data were collected as follows: from the experimental group, there were 52 students (28.8% female) at the pre-test, and 29 students (37.9% female) at the pre-test, while from the control group, data were collected from 26 students (34.6% female) at the pre-test and 19 students (47.3% female) at the post-test. Independent t-test analysis showed that the SCL initiative had only a positive impact on student learning approaches and teaching quality as perceived by students. Concerning students' learning approaches, the SCL initiative had no effect. Several interpretations and perspectives of the current study are discussed.

1 INTRODUCTION

Teaching quality enhancement to improve student learning is still an ongoing concern for most higher education institutions worldwide. Specifically, in Europe, mainly because it influences student achievement, since the Bologna Process, student-centered learning (SCL) became the primary instructional approach (Stes et al., 2012). SCL, among other aspects, focuses on the student's needs (e.g., the curriculum and courses are more flexible, the learning process is more interactive), aiming to facilitate students' adoption of deep learning approaches (Kember, 2009). Therefore, many resources were invested to improve staff development initiatives, develop efficient *instructional development programs* (IDPs), assess and enhance teaching quality, offer incentives for teaching excellence, etc. (Stes et al., 2013). Consequently, there is a massive requirement for quality evidence of IDPs' or staff development impact on daily teaching practices (De Rijdt et al., 2013).

Some studies treated IDPs and the staff development concept as similar concepts. Hence, they have several related terms: academic development, instructional training, educational development, faculty, or professional development. In this study, IDPs and staff development initiatives are treated as correlated but different constructs. Thus, we will refer to IDPs as any initiative precisely planned to enhance academics' teaching (i.e., in their role as a teacher) to support student learning (Stes et al., 2010b). On the other hand, we will refer to staff development initiatives as a sum of informal (e.g., exchange of ideas among teachers) and formal (e.g., workshops) learning experiences of the teacher (Fullan, 1990). In staff development initiatives, academics have to translate their acquired competencies (e.g., knowledge, skills, attitudes) into changes in their thinking and educational behavior. Therefore, in the present study, we will consider (Baldwin and Ford, 1988) definition to define the transfer of the acquired competencies (e.g., learning) to the workplace (i.e., in the classroom) due to IDPs or staff development initiatives.

However, mainly because of the limited resources, in the regular practice, IDPs' and staff development initiatives impact is generally assessed at one level

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(e.g., teachers' attitude or knowledge, students' learning approach, or perception of teaching quality) (Stes et al., 2010a; Stes et al., 2012). The latest reviews in the impact assessment of staff development recommended that the impact of IDPs should be measured on several levels of outcomes (Kirkpatrick and Kirkpatrick, 2006) by well-designed studies (e.g., with at least a quasi-experimental or a longitudinal approach) (Ilie et al., 2020; Stes et al., 2010b). Even though not without limitations, the present article aims to bring more evidence regarding a specific SCL teaching initiative (i.e., as a result of attendance of an IDP and of a staff development initiative) of learning transfer to the workplace. *Using a quasi-experimental design with pre- and post-test, the current endeavor evaluated the impact at two different levels: students' perceptions of teaching quality and students' approaches to learning.*

Students' perceptions of teaching quality or student evaluation of teaching (SETs) represent one of the most voluminous literature research works in the applied psychology field (Ginns et al., 2007). Paper (Marsh, 2007) suggests that teaching evaluation in higher education institutions is important for two main reasons. First, through this evaluation, one can improve teachers' performance by offering them feedback and designing IDPs directed on the identified training needs. Second, one can use the results from SETs in administrative decisions like promotion, rewards, and external accountability. Regarding the impact of IDPs or staff development initiative on students' perceptions of teaching quality, most of the studies presented mixed results (e.g., positive impact (Gibbs and Coffey, 2004; Meizlish et al., 2018); negative impact (Stes et al., 2013). Therefore, for a clearer picture, more studies are needed.

Nowadays, successful learning and studying in higher education is most often associated with students' deep approaches to Learning (Asikainen, 2014). A deep learning approach is characterized by significant engagement in the learning process, independent thinking, analytic skills, and understanding of the subject matter (Asikainen and Gijbels, 2017). On the other side, there is the undesired surface learning approach. Its short-term benefits involve memorizing the subject matter without understanding its utility or implications (Asikainen and Gijbels, 2017). Nevertheless, helping students transition towards a deep approach to learning is not an easy task (Baeten et al., 2010). Few studies showed that students attending classes held by teachers who completed an IDP increased their deep learning approaches compared to the students from the control group (Gibbs and Coffey, 2004). Nonetheless, studies investigating the students' level changes due to their teachers' participation in an IDP are scarce (Ilie et al., 2020).

1.1 Design and Aim of the Study and Hypotheses

The present study used a quasi-experimental design including a pre-test and post-test to assess the transfer into the workplace of an SCL initiative. More precisely, the present study evaluated the degree of the transfer into the workplace of an SCL approach into the context of teaching the Software Engineering subject for bachelor Computer Science students. Therefore, we evaluated the changes in students' perception of teaching quality and students' approaches to learning. Specifically, we advanced three research questions:

Q1. Is there any progress in students' approaches to learning from the experimental group due to the learning transfer into the workplace of the SCL initiative implemented by their teacher?

Q2. Are there any statistically significant differences between the experimental and control group students regarding their approaches to learning?

Q3. Is the teacher's teaching that implemented the SCL initiative perceived as better by her students than students' perception of the teaching of her counterpart in the control group at the end of the semester?

Before introducing the method and results of the study, we present an outline of the learning transfer into the workplace of an SCL initiative in question.

1.2 Research Context

West University of Timisoara, Romania, organizes and encourages participation at several IDPs that promote SCL. The first author of this paper participated in an IDP and a staff development initiative. The IDP (i.e., University didactics and psychopedagogy) was attended between February and March 2020, having the following structure: 5 disciplines, cumulating 150 hours, of which 40 hours theoretical courses (10 hours/discipline, within four disciplines) and 80 hours of practical applications (20 hours/discipline, in 4 disciplines - The Management of the Students Groups, Elaboration of the Didactic Materials, Modern Methods of Education, Curricular Design) and 30 hours of practical applications in the fifth discipline (i.e., Feedback and Didactic Counseling). The primary purpose of this IDP was to improve the level of competencies of the university teaching staff regarding the development of educational offers with innovative and student-centered instructive-educational content and approaches. Regarding its gains, besides belonging to a learning community, at the end of the IDP, each participant has a complete curricular package (e.g., syllabus, teaching strategies, activity plans, assessment tools, etc.) for a discipline they teach in the current practice.

After graduating from the early mentioned IDP, the first author applied and won one of the twenty didactic incentives (i.e., inside the competition Didactic Grants) supported by the university to further implement the SCL approach in the classroom. The staff development initiative (i.e., Didactic Grants Competition) involved a training schedule similar to the University didactics and psychopedagogy IDP (but much shorter and less complex), plus several other informal activities (e.g., informal counseling meetings via Google Meet). As a graduate of the IDP, the first author of this paper did not have to repeat the training activities. However, she was supposed to complete all the other outputs of the Didactic Grants Competition initiative (e.g., design three activity plans and implement at least one of them; record a teaching activity, etc.). Thereby, in the summer semester of 2021, she applied the acquired competencies in the IDP and the staff development initiative to the lecture and laboratory of Software Engineering, a new subject in her teaching portfolio.

1.3 Learning Transfer into the Workplace of the SCL Initiative

Regarding the adopted SCL approach, we mention that the discipline taught to the experimental group was Software Engineering, second year, undergraduate level. Introductory topics in this field were presented based on the books (Van Vliet et al., 2008) for the course, respectively (Seidl et al., 2015) for the laboratory. The chosen topics were such that they prepare the students to understand the basic notions when working for software companies and writing their Bachelor thesis at the end of the third year. At this aim, the lecture was structured as follows: (1) *Software Management:* The Software Life Cycle and variants (advantages and disadvantages): The Waterfall Model, Agile Methods, Prototyping, Incremental Development, Rapid Application Development, and DSDM, Extreme Programming; The Rational Unified Process (RUP); Intermezzo: Maintenance or Evolution; Software Product Lines; Process Modelling; (2) *The Software Life Cycle:* Requirements Engineering; Modelling; Architecture; Design. The laboratory focused on UML modelling, emphasizing the following topics: Use-case diagram, Class diagram, State-machine diagram, Sequence diagram, and Activity diagram. All the semester, the classes were held online due to the Covid19 breakthrough. During the semester, the most challenging was to keep the students focused and engaged. At this aim: (1) we designed the course and laboratory to be very interactive, and (2) the knowledge assessment was continuous during the whole semester. In the Romanian university system, each course and laboratory last 90 minutes. We did our best to divide this time as follows: (1) Clearly define the objectives of the current course and laboratory and relate them with the learning results of the discipline and with previous and future ones. (2) A session in which the teacher presented new material was of maximum 20 minutes and was always followed by a practical session (individual or in teams) and a reflection of what was taught. (3) We tried that each course/laboratory was concluded with a summary of what was studied. This summary was presented by a student randomly chosen from the group (to keep students' attention). The knowledge assessment was done continuously during the semester. It was composed of: (1) quizzes during the lecture, (2) examination in the exam session composed of short questions and synthesis subjects to prove that the students deeply understood the topics, and (3) team project for the laboratory. These three components summed up 10 points, which is the maximum grade in the Romanian grading system. There was also the possibility to choose an individual project on actual topics of research in software engineering. This, together with excellent activity during the semester (at least 9 points for quizzes and team project), would have given the students the possibility to have the maximum grade without taking the final examination in the exam session.

2 METHOD

2.1 Participant Characteristics

Students in both experimental and control groups were similar in terms of faculty (i.e., Faculty of Mathematics and Informatics), specialization (i.e., Applied Informatics), year of studies (2nd year), degree (i.e., bachelor's degree), the academic status of their teacher (i.e., University lecturers), and teaching experience of their teacher (i.e., $>$ 5 years). As compared to the teacher who was the one responsible for the learning transfer into the workplace of the SCL initiative, the counterpart teacher (i.e., the teacher from the control group) did not follow any IDP or staff development initiative on SCL. The distribution of students' mean age, gender, class size and type of activity, and area of residence are presented in Table 1.

2.2 Measures

For the data collection, we used two instruments *Revised Two-Factor Study Process Questionnaire* (R-SPQ-2F (Biggs et al., 2001)) and *Exemplary Teacher Course Questionnaire* (ETCQ (Kember and Leung, 2008)), both being previously used on the Romanian population (Smarandache et al., 2021; Ilie et al., 2021). The R-SPQ-2F measures students' preferences for study strategies (Asikainen and Gijbels, 2017). The R-SPQ-2F has 20 items, assessing two learning approaches, namely the deep and surface learning approach. Each dimension of the R-SPQ-2F is divided into two corresponding subscales (i.e., motives and strategies). The items gather answers through a 5-point Liker scale (i.e., from 1 = never/only rarely true of me to 5 = always/almost always true of me). In terms of factorial structure of R-SPQ-2F, we used the 2-factor one as it proved to be superior on the Romanian population (Smarandache et al., 2021). The deep learning approach scale measures students' motives and strategies described by intrinsic motivation and maximization of their understanding of the discipline. On the other hand, the surface learning approach describes motives and strategies related to extrinsic motivation involving memorizing the course without understanding its implications or utility. We chose the ETCQ mainly because of its validity, reliability, and diagnostic power (Kember and Leung, 2008, p.352). The ETCQ has 49 items, assessing nine dimensions (Table 5) of the teaching process in the classroom environment as perceived by students. The responses to each of the nine dimensions of ETCQ were gathered with a 5-point Likert scale (i.e., ranging from 1 = strongly disagree to 5 = strongly agree). Reliability coefficients for the two scales of the R-SPQ-2F and the nine scales of ETCQ for both the control and experimental group at the two collection data time points (i.e., pre- and post-test) are presented in Table 2.

2.3 Data Collection

We used the aforementioned instruments and assembled a quantitative pre-test (first week of the semester) and a post-test (last week). Participation in the current study was voluntary for all students, and all answers were anonymous. Before completing the questionnaires, a researcher read one standard procedure to fill in the questionnaire. Each student had an anonymous research code to help the research team match their answers from pre-test to post-test. However, excepting the repeating students (i.e., which were too few) the rest of the students that participated in the post-test, according to the research code, were not the same as those in the pre-test. In the case of R-SPQ-2F, data were collected for both pre-test and post-test. Students were instructed to report their general study approaches about the study program they followed (i.e., Applied informatics) at the pre-test. On the other hand, at the end of the semester (i.e., at the post-test), students were asked to report their specific learning approaches in the case of the followed discipline (i.e., Software Engineering in the case of the experimental group and Databases Administration in the case of the control group). As students cannot accurately refer to the teacher's behavior with whom they did not study before, in the case of ETCQ, data were gathered only in the post-test moment.

2.4 Data Analysis

First, we assessed Cronbach's α for each experimental and control group subscale for pre-test and post-test moments. All the obtained values for Cronbach's α indicated acceptable reliability, with almost all scales having good or very good reliability ($\alpha > .80$) (Table 1). Second, given the design of our study (i.e., same teachers and courses were considered for both pre-test and post-test moments) and that only a few students answered the questionnaires in both evaluation moments, we could not perform a paired sample t-test. Therefore, to determine that involved the inspection of normality and homogeneity of variance assumptions: normal plots, stem and leaf plots, and the calculation of skewness and kurtosis were used to verify the normality of the data distribution, while the Levene statistics were calculated to test the equality of group variances. All the preliminary assumptions for the analysis were met (i.e., we have a continuous dependent variable; the independent variable has two categorical, independent groups; the observations are independent; there are no significant outliers; the data distribution is normal) for most of the ETCQ dimensions, excepting the active learning dimension where the equal variances assumption was violated. Therefore, in the case of the active learning dimension, we followed the recommendation of (Howell, 2012), and we performed the Welch t-test (i.e., the nonparametric version of interdependent t-test), while for the rest of the R-SPQ-2F and ETCQ dimensions, we used the interdependent t-test.

Table 1: Demographic characteristics of the student sample.

Students' characteristic	Pre-test		Post-test	
	Experimental group	Control group	Experimental group	Control group
Mean age	20.31	20.73	21.14	20.74
Gender				
Female	15	9	11	9
Male	33	16	16	10
Not mentioned	4	1	2	0
Class size & type of activity				
$\leq$ 30 students (seminary)	-	26	-	19
>30 but $\leq$ 60 students (lecture)	52	-	29	-

Table 2: ETCQ and R-SPQ-2F α Cronbach's indices for the experimental and control group at the pre-test and post-test.

Questionnaire / scale	Moment	No. of items	Alpha Cronbach α	
			Experimental group	Control group
Revised Two-Factor Study Process Questionnaire (Biggs et al., 2001)				
Deep Learning Approach	pre-test	10	.810	.687
	post-test		.853	.837
Surface Learning Approach	pre-test	10	.797	.803
	post-test		.847	.837
Exemplary Teacher Course Questionnaire (Kember and Leung, 2008)				
Understanding Fundamental Concepts	post-test	5	.826	.842
Relevance	post-test	5	.743	.859
Challenging Beliefs	post-test	6	.885	.823
Active Learning	post-test	5	.702	.873
Teacher-Student Relationships	post-test	5	.797	.886
Motivation	post-test	6	.868	.883
Organization	post-test	7	.944	.942
Flexibility	post-test	5	.868	.948
Assignments	post-test	5	.760	.655

Table 3: Student's approaches to study at the beginning, respectively at the end of the semester for students in the experimental group.

Group		Deep Learning Approach			Surface Learning Approach		
		Mean score	SD	N	Mean score	SD	N
Experimental	Before	2.72	0.66	52	2.44	0.68	52
	After	2.66	0.72	29	2.49	0.78	29
	Change	-.06			.05		
	t	.417			-.295		
	p	.678			.769		

3 RESULTS

Research Question 1. Regarding the scores of the students in the experimental group, Table 3 presents their approaches to studying at the beginning and the end of the semester, respectively. No statistically significant improvements can be discerned. However, there is an elusive decrease in the deep learning approaches from the pre-test to the post-test moment (i.e., change = -.06 with Mpre-test = 2.72, Mpost-test = 2.66), respectively an elusive increase (i.e., change = +.05 with Mpre-test = 2.44, Mpost-test = 2.49) in students' surface learning approaches.

Research Question 2. As of Table 4, there are no statistically significant differences between the two groups of students regarding their approaches to learning none of the assessment moments.

Research Question 3. Independent t-test analy-

Table 4: Comparison between experimental and control group before and after the end of semester regarding student's learning approaches.

Variables	Moment	Group						t	df	p
		Experimental			Control					
		N	M	SD	N	M	SD			
Deep Learning Approach	pre-test	52	2.72	0.66	26	2.74	0.54	-0.089	76	0.93
	post-test	29	2.66	0.72	19	2.89	0.66	-1.140	46	0.26
Surface Learning Approach	pre-test	52	2.44	0.68	26	2.60	0.65	-0.969	76	0.34
	post-test	29	2.49	0.78	19	2.79	0.73	-1.327	46	0.191

sis for the differences in students' perception of the teaching quality revealed statistically significant differences for only three out of the nine scales of the ETCQ (Table 5). First, there is a marginally statistically significant difference regarding the active learning behaviors of the two teachers: the students in the experimental group reported more behaviors of their teacher that encouraged and facilitated their active learning than the students in the control group (t[27.76]= 1.891, p = .069, d Cohen = 0.58). Second, students in the experimental group reported lower scores concerning their relationship with their teacher than students in the control group, which said they had a better relationship with their teacher (t[46]= -2.065, p = .045, d Cohen = 0.61). Third, there is a marginally statistically significant difference regarding the organization of the two courses. Students from the control group perceive their classes to be better organized by their teacher (t[46]= -1.795, p = .079, d Cohen = 0.53).

4 DISCUSSION

In the current study, we investigated the impact of learning transfer into the workplace of an Applied informatics higher university teacher by implementing a student-centered learning (SCL) initiative during one semester on a new subject in its portfolio. Hence, we evaluated the SCL initiative's impact on two levels: students' approaches to learning and students' perception of the teaching quality (i.e., which is also a measure for teacher's teaching behaviors).

Regarding the first two research questions of the current investigation, the SCL initiative did not have any impact on students' learning approaches. There were no improvements either on the deep approaches to learning or on the surface learning approaches of the students in the experimental group. Also, there were no differences regarding students' learning approaches between the control and experimental group. At the end of the semester, students in both groups had the same learning approaches in the two disciplines as, in general, in their bachelor study program. Our results differ from several other studies, which found that students of academics that participated in an IDP or a staff development initiative were more likely to adopt deep learning approaches (Gibbs and Coffey, 2004). On the other side, a recent study by (Asikainen and Gijbels, 2017) concluded that most of the existing studies do not exhibit clear empirical evidence proving that students develop deep approaches to learning during higher education. Moreover, several other studies showed that the deep approach to learning does not necessarily develop during university studies. Students' deep approach to learning during bachelor study years could decline (Lietz and Matthews, 2010) while the surface approach develops (Geitz et al., 2016).

Concerning the third research question of the present study, there were both expected and unexpected results. The SCL initiative had a positive impact only on the active learning dimension out of the nine dimensions of teaching quality perceived by the students. Effect sizes point towards a medium practically exciting impact of the SCL initiative on the scale of Active learning (d Cohen = 0.58). One of the reasons why the Active learning variable is higher for the experimental group could be because the individual quizzes and/or group tasks were constantly assigned during lectures. Also, a group project with different milestones was set, and feedback was given to all the teams in the experimental group. This result is in line with some other studies (Gibbs and Coffey, 2004; Meizlish et al., 2018). For example, (Meizlish et al., 2018) found a positive impact of an IDP for debutant academics towards students' ratings, showing a statistically significant increase in the experimental group compared to the control group. On the other hand, students in the control group reported higher scores on their teacher's behaviors regarding the Teacher-Student Relationships and Organization of the course. This result could be explained by the fact that the discipline taught by the teacher who implemented the SCL initiative was new in her teaching portfolio, this being not the case of the counterpart teacher. Another possible reason could be that students in the experimental group perceived the numerous tasks and

Table 5: ETCQ dimension scores for the experimental in comparison to the control group at the post-test moment.

ETCQ Scale (Group)	N	SD	Mean score	t	df	p	Change	d Cohen
Understand Fundam. Concepts								
Experim Grp	29	3.68	0.75	-1.252	426	0.217	Same	-
Ctrl Grp	19	3.97	0.86					
Relevance								
Experimental Grp	29	3.73	0.71	-0.178	46	0.859	Same	-
Control Grp	19	3.77	0.71					
Challenging Beliefs								
Experimental Grp	29	3.46	0.92	0.475	46	0.637	Same	-
Control Grp	19	3.34	0.70					
Active Learning								
Experimental Grp	29	4.21	0.56	1.891	27.76	0.069*	Better	0.58
Control Grp	19	3.79	0.87					
Teacher-Student Relationships								
Experimental Group	29	3.35	0.81	-2.065	46	0.045*	Worse	0.61
Control Grp	19	3.84	0.79					
Motivation								
Experimental Grp	29	3.41	0.92	-0.839	46	0.406	Same	-
Control Grp	19	3.63	0.81					
Organization								
Experimental Grp	29	3.45	1.01	-1.795	46	0.079*	Worse	0.53
Control Grp	19	3.96	0.90					
Flexibility								
Experimental Grp	29	3.92	0.82	-0.894	46	0.376	Same	-
Control Grp	19	4.15	0.95					
Assignments								
Experimental Grp	29	3.81	0.78	0.115	46	0.909	Same	-
Control Grp	19	3.79	0.61					

homework during the semester and their consistent application as too strict. Also, in most disciplines, students are being evaluated mainly in the examination session. Thus, as suggested by other studies, teachers must allocate extra time to successfully implement what is learned during instructional development in daily practice(Gibbs and Coffey, 2004; Stes et al., 2010a). (Postareff et al., 2008) showed that changing the paradigm to a SCL approach is slow and progressive on the teachers' side. Hence, one semester counting 14 weeks may not be sufficient for visible results. However, several studies which measured the impact of an IDP or staff development initiative reported no, limited, or even negative effects (Stes et al., 2012; Stes et al., 2010a).

Limitations and Future Directions. The main limitation of the current endeavor is the low number of students in the two groups and the impossibility of matching all the responses in the two assessment moments. As a consequence, our statistical power is very low. Second, the employed design is quasi-experimental (i.e., lack of randomization). Third, because of limited resources, we assessed the impact of the SCL initiative only through quantitative investigation. Thus, we should be cautious in interpreting present results for the early mentioned reasons and not only. Future studies should consider employing an experimental design (i.e., conducting a randomized controlled trial), quantitative and qualitative measurements (e.g., classroom observations, interviews, etc.), and most importantly, good statistical power. Also, if possible, one should obtain answers from the same students in the pre-test and post-test.

5 CONCLUSIONS

In this paper we presented the effect of an SCL initiative through a quasi-experimental design, with a pre-test and post-test assessment. We showed that transferring learning into the workplace of an Applied informatics higher university teacher by implementing student-centered learning (SCL) is perceived as positive by the students. However, creating an active learning environment may not be enough to convince them to change their usual learning approaches. Hence, one should strive to transfer their learning into daily practice to influence student learning positively.

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