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Effectiveness and Stakeholders' Perceptions of the Integration of Automated E-Learning Courses into Vocational Education Programmes in Universities in Ukraine

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Abstract. The purpose of this research was to identify whether the integration of the automated vocational e-courses into vocational education could bring the students to the same academic achievements as the tutor-moderated ones, and whether the stakeholders of education perceive the automation of e-learning positively or negatively, and what impact factors triggered their perceptions. The baseline study used the e-course evaluation checklist to assess the e-course structure and content from eight randomly selected universities. Four hundred and four students and thirty-one instructors participated in the baseline study, first pilot, and core experiment. The instruments utilised to monitor the variables in the pilots were as follows: the sampled students' academic records, a Criteria Cognitive Aptitude Test, a Rasch Measurement Model, and the Kolb's Learning Style Questionnaire. The IBM SPSS Statistics 5.0.0.1. Software package was used to process the data drawn for the above measurements. The above measurements were followed by the focus group and nine education stakeholders' perceptions analyses using the Triangle Assessment Method. The study provided new evidence that automated e-course delivery can lead to approximately the same statistically significant improvements in the students' vocational competence, academic motivation, and learning styles proving that it

might be considered to be a feasible instructional tool. Additionally, it suggested that the use of automated educational e-course assisted by a virtual agent had been a more cost-efficient option.

Keywords: vocational education programme; e-courses automation; vocational competence; academic motivation; learning styles

1. Introduction

The integration of the automated e-learning courses in the vocational education is gradually becoming a preferred cost-efficient option for tertiary institutions worldwide and in Ukraine, but an instructional challenge for the teachers (Latchem, 2017; Diachenko et al., 2019; Katambur, 2019). This trend is consistent with the fifth-generation distance education model (The Intelligent Flexible Learning Model) that is featured with the tools of interactive, internet-based, technology-mediated communication (Moller, Robison & Huett, 2012). The model can provide the learners with the conventional-like quality of education for a significantly lower cost (Mirrlees & Alvi, 2020). The greatest challenge for the educators who have been recently forced to design and deliver the distance courses is a struggle to create and work online learning environment caused by a lack of computer skills. The teachers are supposed to apply more constructivists pedagogies based on new tools, approaches, and methods (Iskander, Kapila & Karim, 2010). Additionally, instructors are reluctant to shift to the use of the distance learning models, especially automated ones, as this shift entails teachers and institutions getting rid of traditional classroom instruction followed by losing jobs by teachers (Dovbenko et al., 2020).

It is also a trend-driven innovation (CommLab India, 2020) that meets the principles of the current educational policy of Ukraine (Bobrytska, 2015; Bobrytska, 2017; Reva, 2017) and requirements associated with education accessibility, affordability, and effectiveness (Chivu et al., 2018). Besides, it is consistent with the ideas of both a new paradigm of 21st-century education (Cunningham, 2019) and robotics-based education (Alimisis, 2020). Interestingly, the recent developments in Speech and Language Technology (SLT), AuthorIT & TutorIT technologies have made it possible to substitute a human-run learning environment losing no instructional quality and ensuring high-cost effectiveness (Delić et al., 2019; Cernak, Asaei & Hyafil, 2018; Scandura, 2010; Scandura, 2016). The letter inspired this study and created a research gap as the study found insufficient limits of information on the use of virtual tutor's assistants in the course delivered on the Moodle platform.

Literature review

The literature review found that theory, methods, quality assurance and effectiveness issues of vocational education in universities in Ukraine are thoroughly investigated and revealed (Bobrytska, 2015; Bobrytska, 2017) in terms of reshaping and adjusting it to the international job market, and making it more 'real life-friendly.' (Tsymbaliuk, Shkoda & Artiushyna, 2019). The literature review found an extensive body of research revealing the use of technology in educational settings. The relevant and credible works show that there is the relationship between the use of information communication technology (ICT) and

students' academic performance, educational self-efficacy determined by the ability to navigate in the flow of information, to acquire new knowledge, to self-develop professionally (Bobrytska, 2015; Bobrytska & Protska, 2017; Bobrytska & Protska, 2018; Chkhalo, n.d.; Saxena, 2017; Balali, Ahmadi, Tabatabaei & Hassani, 2018; Basri, Alandejani & Almadani, 2018).

The irruption of Intelligent Tutoring Systems and Artificial Linguistic Internet Computer Entity (A.L.I.C.E.) gave rise to emerging breaking educational projects (Smutny & Schreiberova, 2020; Laurillard, 2013; Holotescu, 2016; Garrett, 2017; Fadhil & Villafiorita, 2017) based on the use of the Facebook Messenger (Smutny & Schreiberova, 2020). Furthermore, educational projects to teach learners a language are coming into practice. They are using a conversational chatbot substituting a teacher and based on Computer Assisted Language Learning (CALL) systems used as a media (Shawa, 2018). The chatbot can reproduce a standardized dialogue by using a series of written or verbalised messages that can substate the human teacher's lesson delivery. After such a class (a lecture or a presentation, or a lab explainer) the chatbot can assign a student with a multiple-choice test or quiz, immediately check it and forward the results to the teacher or the course moderator. It reduces the teacher's workload and helps the one to engage students in the learning and collaboration process. A chatbot also can track students' information inquiries to be further used to update the content of the e-course (Farkash, 2018).

Though this research problem is quite trendy, it is underrepresented in the literature, specifically from a pedagogical perspective. Therefore, the *purpose* of this research was to identify whether the integration of automated educational courses into vocational education programmes in universities in Ukraine could be effective and perceived positively by education stakeholders.

The research questions were as follows: 1) what delivery structure of the vocational e-courses at universities are commonly used at universities in Ukraine; 2) whether that structure is appropriate to train students' vocational competence; 3) how the automated educational e-courses integrated into vocational disciplines influences students' vocational competence, academic motivation, and learning styles; 4) how the stakeholders of education perceive the automation of e-learning and what factors trigger their perceptions.

2. Research methodology

The study attempted to answer the research questions in the course of the core experiment that was proceeded by a baseline study and a pilot study. It was divided into four stages to have used different designs and methods (see Fig. 1).

Research Design

A descriptive research design was employed to complete a baseline study, which was the first stage of the research by utilising quantitative methods. A quasi-experimental research design relying on pre-testing–post-testing procedures was utilised in the first pilot and the core experiment. The latter both relied on a mixed-methods approach to monitor changes in the dependent variables and perceptions. The fourth stage was analytical that used statistical methods to process data, interpret the results, and draw conclusions. The sampled students' vocational competence, academic motivation, and learning styles were the

dependent variables for the pilot study. The above-outlined variables were kept under systematic review in the core experiment and perceptions of different stakeholders were examined after completing the intervention. The perceptions of automated educational e-course delivery were studied in the core experiment.

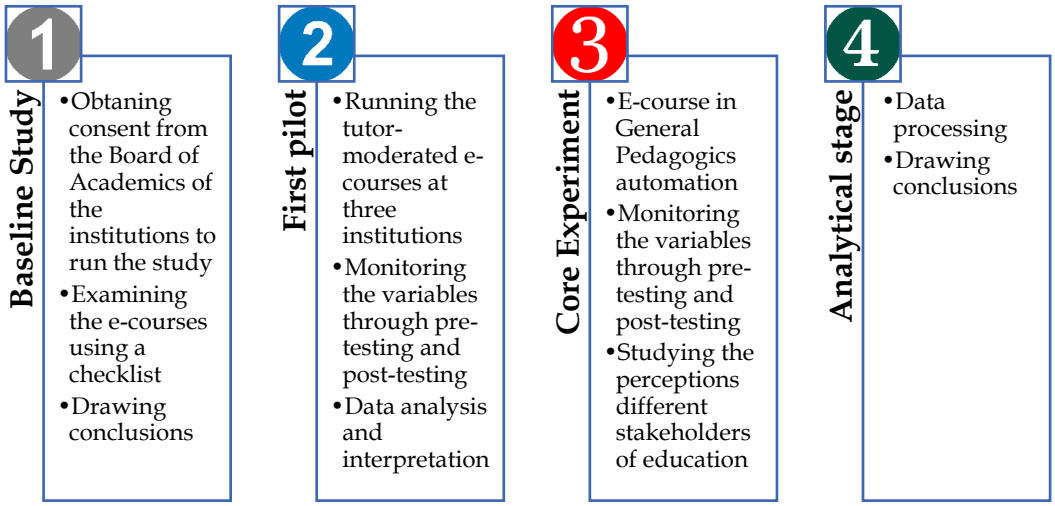


Figure 1: Abstract Research Design

Research Participants and Procedure

The baseline study was conducted at eight leading and highly-rated universities in Ukraine from January to the end of May of 2018. Those were National Pedagogical Drahomanov University (NPDU), Bogomolets National Medical University (BNMU), Borys Grinchenko Kyiv University (BGKU), Kyiv National Economic University (KNEU), Kyiv National University of Technologies and Design (KNUTD), Kyiv National University of Construction and Architecture (KNUCA), Lviv Polytechnic National University (LPNU), and V. N. Karazin Kharkiv National University (KKNU). The consent for running the study was obtained from the Institutional Scientific Review Boards of all universities prior to the intervention.

The purpose of the study was to analyse scientific and methodological approaches used to develop e-courses in different vocational tertiary schools, to examine (mutually considered) best practices of organising and administrating online component of the vocational training, and to specify the structure of e-courses placed on the MOODLE platform. To meet the purpose of the study, two existing online course checklists developed by Federation University (Australia) (n.d.) and Winthrop University (USA) (n.d.) were adapted and refined for the use in this study to evaluate the structure of the course and instructional methods. They were chosen because they comply with Standards and Guidelines for Quality Assurance in the European Higher Education Area (ESG), Articles: 1.2 (Design and approval of programmes), 1.3 (Student-centred learning, teaching, and assessment), 1.6 (Learning resources and student support) (ESG, 2015).

The first pilot lasted from September of 2018 to the end of January of 2019. It was run at three randomly selected institutions, which were as follows: National Pedagogical Drahomanov University (NPDU), Bogomolets National Medical

University (BNMU), Borys Grinchenko Kyiv University (BGKU). The purpose of this part of the experiment was to identify how the revised and updated e-courses impacted on the students' vocational competence (comprising their abilities to communicate to solve problems, obtain and use new information thinking critically), academic motivation, and learning styles compared to conventional course delivery. The e-courses in "Educational policy" (NPDU), "Analytical Chemistry" (BNMU) and "General Pedagogy" (BGKU) were chosen for the experiment for being specialism-related, for being 4 ETCS credits long and for corresponding to the course design requirements developed in the online course checklists for the baseline study.

The population of the students sampled for the first pilot experiment was 358 students seeking Master's Degree in Education (Speciality ref. 01 "Education"), Medicine (Speciality ref. 226 "Pharmacy, industrial pharmacy") and Philology (Speciality ref. 035 "Philology"). The students were recruited from the first and the second semesters of the above programmes. This number was used to form the experimental (EG) and control groups (CG) at each university. The demographics of the groups were as follows: NPDU – 15 people in the EG and 15 people in the CG; BNMU – 68 students in the EG and 68 students in the CG; BGKU – 98 students in the EG and 99 students in the CG. 73% of the sampled students were females aged between 22 and 24, and 27% of the participants were males of the same age.

Core experiment procedure

At this stage, the study attempted to test the educational effectiveness of the automated e-learning course and to examine the education stakeholders' perceptions of it. This stage lasted from September of 2019 to the end of January 2020. Two IT Department specialists for National Pedagogical Drahomanov University were involved in the automation of the "General Pedagogy" e-course. The reason for the choice was that this course is in Pedagogics is compulsory for Masters' Degree students of all majors in Ukraine and these study outcomes could be easily disseminated. *Dialogflow chatbot* (formerly known as API.ai) was programmed to serve as a virtual tutor's assistant in the course delivered on the Moodle platform. The chatbot was expected to verbalise lectures, commonly used instructions to engage the students into a learning process, give feedback, and answer to FAQ, evaluate the students' progress. Those were based on the database of FAQ, solutions to typical issues that could arise in the learning process in the pilot study. The content and structure of the automated course were identical to those in the pilot study.

Sampling for the core experiment

A randomised sampling technique was used to form the EG and the CG to participate in the core experiment. Forty-six students seeking Masters' Degree in Education National Pedagogical Drahomanov University volunteered and gave informed consent to be involved in the study. Both groups were of the same number of people – the EG counted 23 persons (15 female 18-19-year-olds and 8 male 18-19-year-olds) and the CG comprised 23 students (14 females aged 22-24 and 9 males aged 21-24). The groups were mutually homogeneous as the sampled students were of the similar majors and from the same cohort (educational group).

Twelve volunteers (6 males and 5 females) from the EG were randomly hired for the interview after the experiment.

Research instruments

The instruments used in the research were as follows: the e-course evaluation checklist; the sampled students' academic records (AR); a Criteria Cognitive Aptitude Test (CCAT, n.d.); a Rasch Measurement Model (RMM) (Njiru, 2003); Kolb's Learning Style Questionnaire (LSQ) (2005-2006; Kolb & Kolb, 2013). The IBM SPSS Statistics 25.0.0.1. Software package was used to process the data drawn for the above measurements. The focus group interview based on four open-ended questions was administered to study the perceptions of both students and tutors of the automated format of the course delivery. The interviews were recorded and manually processed by three team members.

Focus group interview questions:

1) How did you feel about doing an automated course? Why?
2) What caused you to feel like that specifically? Why?
3) How did the course influence you in terms of your learning experience? What were the benefits specifically?
4) Would you recommend your friends to buy an automated course? What fee could be charged for such a course, in your view?

The Triangle Assessment Method (TAM) (Pérez-Rodríguez & Rojo-Alboreca, 2017) was applied to analyse education stakeholders' perceptions. The reason for choosing this method was the fact that it involves a comparison of trios rather than pairs of elements that allows increasing the representativeness of the analyses, reducing bias that might result from the repetitive judgements. Nine volunteers (education stakeholders) were involved in the criterion weighting procedure. Those criteria were as follows: convenience, cost-efficiency, effectiveness, innovativeness, technological complicatedness. The education stakeholders expressed their degree of uncertainty associated with each criterion using the five-point scale from 1 meaning 'relatively low degree of uncertainty' to 5 referring to 'total uncertainty'.

Instrument reliability

The checklist used in the baseline study consisted of 68 items distributed under the headings as follows: 1) clear and consistent curriculum design and delivery; 2) clear objectives and outcomes; 4) the content is consistent to the objectives and outcomes; 3) an interface design; 5) a difficulty progression-based structure; 6) a teacher-student (student-teacher) support and communication provision; 7) variety of strategies for content delivery and student engagement; 8) assessment.

Three statistics experts examined and made amendments to the questionnaire so that criterion validity, construct validity, and face validity was ensured. Each item was assigned a code. Before applied, it had been administered to three randomly selected online courses. This was followed by the experts' discussion of the results and overall validity of the instrument. The interrater reliability was measured using the Intraclass Correlation Coefficient (ICC). The obtained value for all checklist scores was 0.68 (95% CI=0.59–0.72). The internal reliability of the checklist was measured utilising Cronbach's alpha and ranged from 0.62 to 0.77 for eight universities. The Cronbach Alpha was used to measure the reliability of

Kolb's Learning Style Questionnaire. The alpha coefficients were between .83 and .86, which fits the estimated values to be higher than .81 (Kolb & Kolb, 2013).

The focus group interview relied on the strategy developed by Krueger and Casey (2015). It used opening, introductory, transition, core, and ending questions. Three statistics experts examined and made amendments to the questionnaire so that it ensured criterion validity, construct validity, and face validity. Every interview was recorded and transcribed. The coding procedure was performed to the themes that have appeared from the interview. The IBM SPSS Statistics software was used to process the responses. The Chi-square was utilised to analyse qualitative data.

3. Results

The baseline study found that a common theoretical framework for the e-course design at those universities was based on such approaches as systematic, competency-based, personality-oriented, and task-based, which indicated the dominance of practical orientation and personification in the organisation and administration of the distance education process. The typical elements for the MOODLE platform-based course structure at the above institutions were as follows: a) information about the course (course overview) (the student finds a course guide, a syllabus, the assessment criteria for completed tasks, *etc*.); b) lectures (a student is provided access to both PDF document versions and presentations); c) assignments for seminars (a student fulfils the assignment themself and a tutor (a course-moderator) provides feedback electronically); d) assignments for practical classes (a student fulfils the assignments themself and get feedback from the tutor electronically); e) a block of self-study work; f) an assessment block (tests are administered electronically and cover specific topics, modules or the whole course) (see Fig. 2).

The structure of the e-course may vary depending on the specificity of teaching methods used to deliver certain academic discipline and technological capabilities of the information system of the institution. Recommendations, which were an outcome of the baseline study, were used in three institutions to revise and improve the existing e-courses. Those institutions were National Pedagogical Drahomanov University (NPDU), Bogomolets National Medical University (BNMU), Borys Grinchenko Kyiv University (BGKU). The automated educational e-course was designed based on the above structure and was used in the first pilot and core experiment.

At the first pilot stage, both the sampled students' academic records (AR) and a Criteria Cognitive Aptitude Test (CCAT) were administered to assess students' vocational competence. The academic motivation was measured by a Rasch Measurement Model (RMM). The changes in students' learning styles were measured through Kolb's Learning Style Questionnaire (LSQ). The results of the measurements are presented in Table 1.

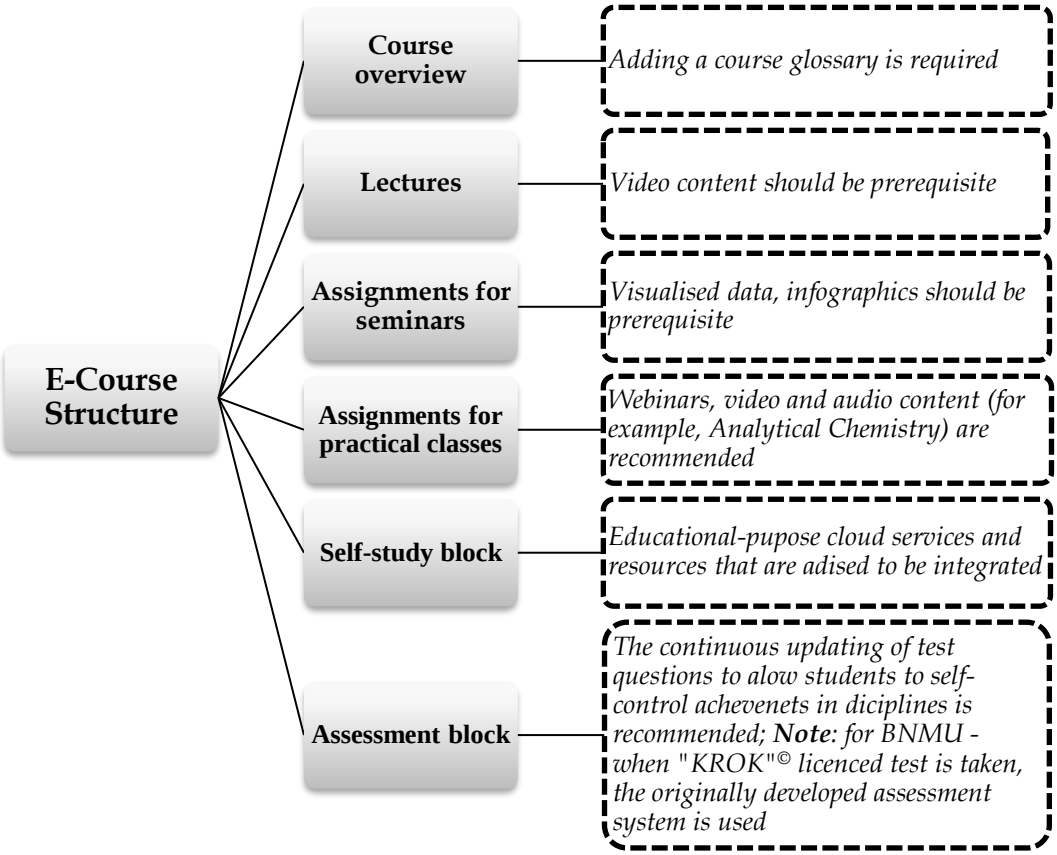


Figure 2: The e-course structure with recommendations on improvements resulted from the baseline study

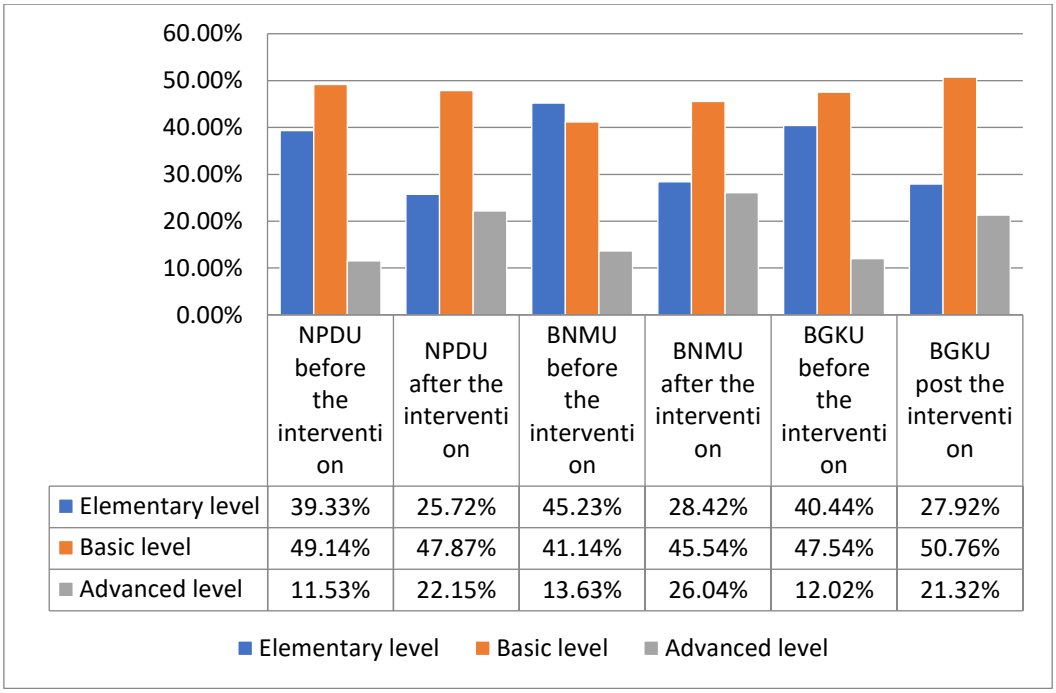
Table 1: Mean values from AR, CCAT, RMM and LSQ measurements, Cronbach's alpha, t-test, and p values (in the EG and CG, before and after the educational intervention)

Axis	Group	*Mean*		*Alfa*		*SD*		*Test*	
		B	A	B	A	B	A	*t*	*p*
AR	EG	7.73	9.32	.42	.57	2.669	2.879	2.4371	0.0001
	CG	7.59	8.81	.41	.48				
CCAT	EG	13.23	18.23	.47	.59	2.157	2.313	1.5119	0.0029
	CG	13.22	15.34	.47	.52				
RMM	EG	15.16	17.43	.52	.77	2.557	2.699	1.3332	0.0015
	CG	15.28	16.21	.52	.62				
LSQ	EG	12.43	15.36	.64	.74	3.167	3.332	3.2367	0.0073
	CG	12.38	13.98	.67	.72				

Note: B – Before the Educational Intervention; A – After the Educational Intervention; AR – academic records; CCAT – Criteria Cognitive Aptitude Test; RMM – Rasch Measurement Model; LSQ – Learning Style Questionnaire.

As can be seen, the mean values from all measurements as well as Cronbach's Alpha figures improved, which indicated that the e-courses had triggered a more significant change in the variables than the conventional learning mode. The *p*-value of 0.001 for AR is statistically significant meaning that overall students' academic performance is quite high.

To enhance the reliability of the study results, the three-level scale was developed to assess the students' vocational competence. The scale included "Elementary level", "Basic level", and "Advanced level". The measurements were administered in both groups. The results are presented in Fig. 3.



	NPDU before the intervention	NPDU after the intervention	BNMU before the intervention	BNMU after the intervention	BGKU before the intervention	BGKU post the intervention
Elementary level	39.33%	25.72%	45.23%	28.42%	40.44%	27.92%
Basic level	49.14%	47.87%	41.14%	45.54%	47.54%	50.76%
Advanced level	11.53%	22.15%	13.63%	26.04%	12.02%	21.32%

Figure 3: The assessment results of the students' vocational competence using the three-level scale

The data in Figure 3 indicated that due to the e-courses the students experienced a positive change in their vocational competence. It implied that the educational process, in general, in NPDU, BNMU, and BGKU improved as well. It was statistically proved by the Pearson consistency criterion (χ^2). It was found that the difference between the groups before the experiment and after the experiment was statistically significant (respectively $\chi^2 = 3.43$ and $\chi^2 = 9.22$). The mean value of $\chi^2 = 6.32$ with $\alpha = 0.05$ and the figure for $df = 2$.

The core experiment results

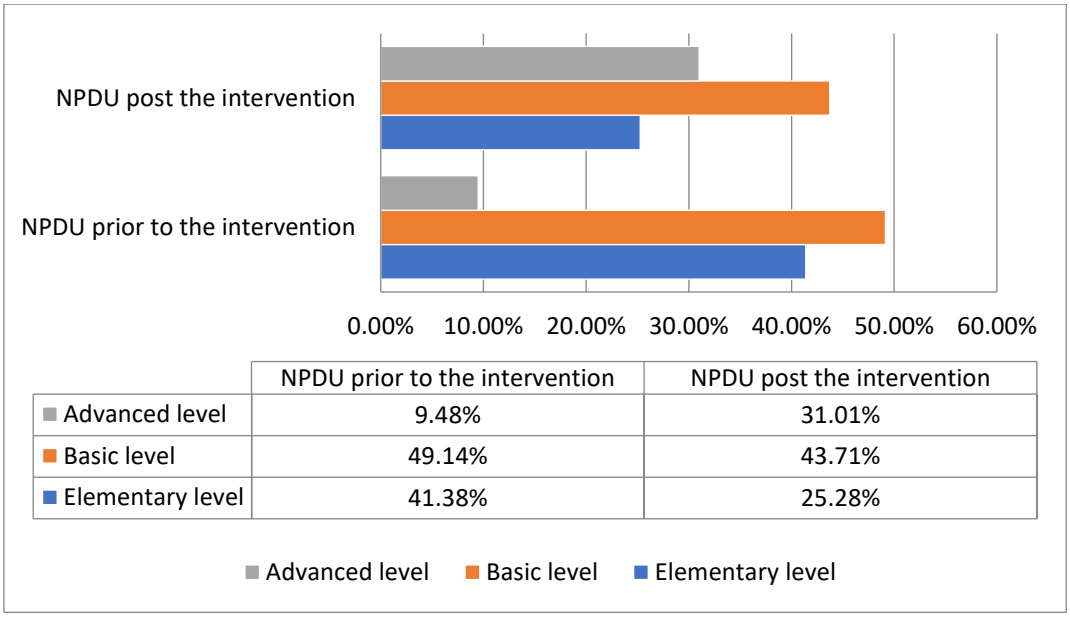
Overall, the results of measurement to have been administered after completion of the automation of the "General Pedagogy" e-course at the stage of the core experiment showed that both sampled groups (EG and CG) experience almost the same change in variables as they had in the first pilot study. It implied that the automated educational e-course could be as efficient as the tutor-moderated one. The results that were drawn from AR, CCAT, RMM, and LSQ measurements before and after completing the automated e-course presented in Table 2.

Table 2: Mean values from AR, CCAT, RMM and LSQ measurements, Cronbach's alpha, t-test, and p values (in the EG and CG, before and after completing the automated e-course)

Axis	Group	*Mean*		*Alfa*		*SD*		*Test*	
		B	A	B	A	B	A	*t*	*p*
AR	EG	7.29	8.92	.41	.49	2.548	2.835	2.1199	0.0003
	CG	7.31	7.91	.43	.47				
CCAT	EG	12.15	17.93	.46	.55	2.246	2.412	1.6712	0.0017
	CG	12.18	14.94	.45	.54				
RMM	EG	16.76	17.51	.54	.73	2.479	2.572	1.3592	0.0018
	CG	16.81	15.87	.53	.68				
LSQ	EG	13.76	16.81	.61	.67	3.254	3.412	3.5134	0.0032
	CG	13.69	14.85	.63	.68				

Note: B – Before the Educational Intervention; A – After the Educational Intervention; AR – academic records; CCAT – Criteria Cognitive Aptitude Test; RMM – Rasch Measurement Model; LSQ – Learning Style Questionnaire.

The three-level-scale-based assessment results of the NPDU students' vocational competence are presented in Figure 4.



	NPDU prior to the intervention	NPDU post the intervention
Advanced level	9.48%	31.01%
Basic level	49.14%	43.71%
Elementary level	41.38%	25.28%

Figure 4: The assessment results of the students' vocational competence using the three-level scale before and after completing the automated e-course

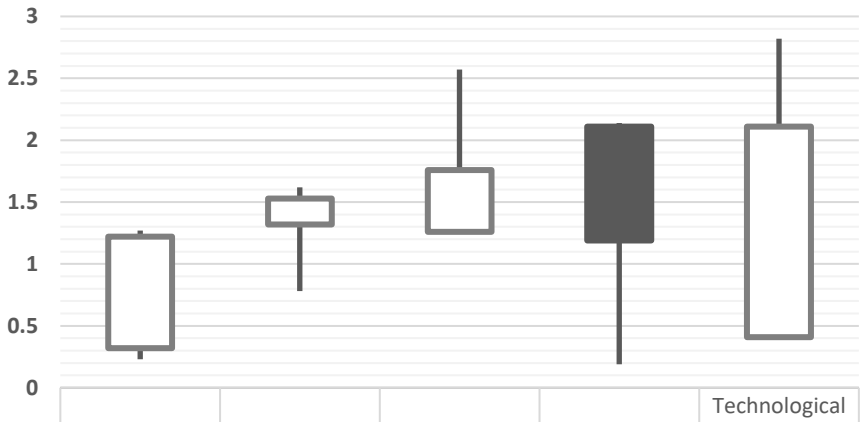
Figure 4 reveals that the change in the students' vocational competence was even more noteworthy that in the pilot study.

Table 3: Focus group interview results (EG students, $n = 12$, $df = 1$)

#Q	Responses	Frequency, %
1	I felt comfortable	53
	I felt engaged and guided personally through the course	35
	I felt quite overloaded	12
2	I liked the opportunity to try out different learning approaches	28

	I liked the immediate feedback	17
	The course was easy to follow and interesting	14
	A course virtual assistant was really helpful to me	31
	The course was flexible and interactive	11
	Theoretical questions took much time to learn and were diffusely formulated	9
3	I have improved my team-working skills	24
	I have improved technology-mediated communication skills	36
	I answer questions quicker	19
	I have become more self-confidant as a learner	21
4	Of course, I would. The fee could be $5 to 10.	38
	I'm not sure.	13
	The course could be worth market value.	49

The above responses showed a generally positive perception of the chatbot-assisted delivery of the e-course. The results of the triangle assessment method presented in Fig. 5 relied on education stakeholders' judgements on convenience, cost-efficiency, effectiveness, innovativeness, technological complicatedness of the automated e-course delivery. Those stakeholders were as follows: two students, two teachers, three university representatives, and two representatives of the students' future professional field.



	Convenience	Cost-efficiency	Effectiveness	Innovativeness	Technological complicatedness
Stakeholder 1	0.32	1.32	1.26	2.11	0.41
Stakeholder 2	1.15	1.13	1.47	2.14	0.62
Stakeholder 3	0.87	0.78	1.87	0.19	1.98
Stakeholder 4	0.23	0.82	1.56	0.24	2.21
Stakegolder 5	0.24	0.91	2.53	0.57	1.76
Stakeholder 6	0.37	1.28	2.57	0.64	1.91
Stakeholder 7	1.27	1.62	1.78	0.76	2.82
Stakeholder 8	1.19	1.32	1.75	0.79	2.67
Stakeholder 9	1.22	1.53	1.76	1.19	2.11

Figure 5: Distribution of the education stakeholders' judgements on weighting the criteria

As can be seen in Figure 5, the education stakeholders' judgments appeared to be quite dispersed for each criterion. However, they showed unanimity and low level of hesitation in their judgements concerning convenience, effectiveness, and innovativeness of the automated e-courses in the tertiary school settings. The stakeholders' views on the innovativeness of the automated learning were also different ranging from students' low level of uncertainty of judgments perception of this delivery format to 'relative lack of uncertainty of judgment' among the university representatives. The views on the technological complicatedness of automation of the educational e-course also varied widely among the stakeholders. Thus, the stakeholders seemed to be certain that the automated e-course delivery was relatively convenient for students and teachers, cost-efficient for the institution, effective as a means of instruction, though technologically complex from the perspective of the institutional representatives and employers.

4. Discussion

The study tested and proved that the use of automated e-course assisted by a virtual agent was feasible in terms of educational and instructional effectiveness, convenience, innovativeness, and, especially, cost-efficiency. It was found in the core experiment that the EG students experienced almost the same change in their vocational competence, academic motivation, and learning styles after completing the automated e-course as they did in the human-tutor moderated one. The results of the measurements of AR, CCAT, RMM, and LSQ before and after the educational intervention showed an average growth of 16% growth. This was supported by the three-level-scale-based assessment and figures for responses of the focus group students. The education stakeholders' judgments were also suggestive. They expressed consent regarding the convenience of the automated education e-course for both students and teachers and its cost-efficiency for the institutions. Their views are supported by the responses from the focus group interview. Fifty-three percent of those interviewed stated that they felt comfortable about the automated format of the course delivery and thirty-five percent spoke positively about the way they had been engaged and guided personally through the course.

The common interviewees' quotes were:

> *[… It was more like a game to play for me. I was just supposed to go to another level…]*
> *[… no hypo-critics, no teacher dominance, no anyone to blame for my failures or mistakes…]*
> *[…flexible working hours, fewer students skipping the classes, easier and simpler classroom management…]*
> *[… I could take time to examine the topic and recheck my results…]*
> *[… in the beginning, I suffered from the challenge, but after a while was proud of myself for meeting it…]*

With regard to cost-efficiency, the respondents stated that

> *[… it could be cheap - $5 to 10 could be charged for the whole course...]*
> *[… the automated course is, for sure, far cheaper than the classroom learning…]*
> *[…one-time money and time investment, can be included in the course-library and sold …]*

The core experiment results met the purpose of the study and complied with previous research on methods of distance learning and teaching in HEIs, design of materials for distance courses, automation of educational support, use of a virtual assistant in the e-course, the use of smart technologies in vocational training. The study is consistent with the theoretical concepts of distance teaching of Burger (2015) stating that the students' results in learning improve due to the application of the individualised training approach and regular student interactions. It goes in line with Kennepohl (2018), who reviewed best practices and teaching tools used in higher e-education instruction, and concluded that distance learning 'create flexible and accessible learning environments moving the emphasis from [memorising] the content to [fulfilling] activities.' The study agrees with Ishii and Tamaki (2009), who evidentiated that the automation of education had an effect on 'educational psychology and educational technology'. According to Smutny and Schreiberova (2020), chatbots served a gamification tool that increased students' learning engagement, and the web sources guide providing links to certain learning content on the Internet.

The results obtained from the triangle method-based assessment comply with the findings of Wasfy et al. (2013), who calculated that a human teacher hourly rate varied between $30 to $100, and the automated course estimated cost was no more than $10 to $50 dollars per course per student. Morales-Menendez, Ramírez-Mendoza and Guevara (2020) in respect of cost-efficiency of automated learning and teaching emphasised that the latter required the low investment and operating costs. The research boosted the theory and methods of automation of education (Ishii & Tamaki, 2009; Wasfy, 2013; Kennepohl, 2018; Diachenko et al., 2019). It made a contribution to the literature on the integration of chatbots in the vocational training process (Hajare et al., 2018; Diachenko et al., 2019; Smutny & Schreiberova, 2020) and the use of smart technologies and AI in tertiary education (Bobrytska, 2011; Zhu et al., 2016; Popenici & Kerr, 2017).

5. Conclusion

The study has contributed to the growing literature investigating the integration of AI agents in the delivery of vocational e-courses. Specifically, we provided new evidence that automated course delivery could lead to approximately the same statistically significant improvements in students' vocational competence, academic motivation, and learning styles. This was supported by the results drawn from students' academic records, the criteria cognitive aptitude test, the Rasch measurement model, and Kolb's learning style questionnaire, before and after the educational intervention which showed an average growth of 16%. It suggests that this course delivery approach seems to be a feasible instructional tool that employs a wider range of pedagogical options of engaging students into learning. For example, the chatbot that was integrated into the automated e-course encouraged students to solve educational problems through interaction and collaboration, evaluated their progress, and stimulated them to increase their academic performance and created an atmosphere of fun and enjoyment. At the same time, it was found that the use of automated e-course assisted by a virtual agent had been a more economical option. Moreover, it was generally positively perceived by the education stakeholders involved in the assessment. However, further research is needed in the assessment of written assignments by a chatbot.

6. Practical implications and research limitations

The major practical implication of the research is that it provides necessary empirical data about trends in the automation of the educational e-learning courses, the optimum or most appropriate delivery structure of the vocational e-courses at universities. The study provides insights into the education stakeholders' perceptions of the automation of e-learning and specifies factors triggering their views.

A second noteworthy implication of the research derives from the finding the automated educational e-course could provide the students with the same educational gains as the tutor-moderated ones but for a much lower cost for the educational institution.

A third implication comes from the technological issues related to both the computer infrastructure and instructors' computer literacy, which are prerequisites for the automation of the educational e-course.

There are several seeming limitations to the study that might cause constructive criticism. First, it is one higher educational institution that participated in the core experiment. Second, the number of sampled students to have participated in experiments and gender issues. Third, the bias of the members of the research team could be considered a limitation.

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8. References

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Appendix

DISTANCE COURSE EVALUATION CHECKLIST

Heading	#	Item
Clarity and consistency of curriculum design and delivery	1	The course syllabus providing course objective and learning outcomes is placed as PDF file.
	2	The course syllabus meets the ISTE Standards teacher standards.
	3	The course syllabus contains technical requirements for accessing the materials.
	4	The course syllabus provides information on expectations for submitting assignments electronically such as file format or resolution.
	5	The course syllabus clearly explains the grading system and policy.
	6	The course syllabus provides information about the expected involvement (attendance) for successful completion of the course online.
	7	The tutorial materials on how to start and how to navigate the course flow are given at the beginning.
	8	The course design complies with the requirements of the National Framework of Qualifications.
	9	The course complies with curriculum in the corresponding discipline.
	10	The course design complies with competency-based approach.
Clarity of objectives and outcomes	11	The learning objectives and outcomes are concise.
	12	The learning objectives are challenging but achievable.
	13	The learning outcomes are measurable.
	14	The criteria for assessment are clear and do not cause misleading or confusion.
Consistency of the content to the objectives and outcomes	15	The learning objectives and outcomes are outlined before every module or unit or the class.
	16	The content of each module or unit or class corresponds the learning objectives.
	17	Each module or unit or class is supposed to bring the students to some measurable learning outcome.
	18	The content is supported with evidence-based explanations.
Interface & course content design	19	The "Start Here" area is present.
	20	The navigation is intuitive.
	21	The calendar of due dates for the assignments is posted.
	22	The copyright issues related to the materials are addressed.
	23	Academic integrity and netiquette are addressed through guidelines for the students.
	24	The cross-cultural context of education is incorporated in the course materials and bias free approach is ensured.
	25	The content of the course is laid out and arranged in manageable portions like modules or units or classes.
	26	The brief overview of each module or unit or class including objectives, activities and resources is provided.

	27	Each module or unit or class is structured according to a unified scheme.
	28	Each module or unit or class includes video content, assignments for seminar, assignments for practical classes, self-study activities or research assignments.
	29	Each module or unit or class includes uses backward design to teach concepts and train skills that are related to both the subject and the real world experiences.
	30	Lectures are recorded using the talking head style.
	31	The typical assignments for seminars are based on visualised data, infographics.
	32	Practical classes delivered through webinars are found.
	33	The self-study block uses educational-purpose cloud services and resources.
	34	The links to supplemental software products are accessed from the course page.
	35	The course glossary is provided.
	36	Learner support section is provided.
	37	All training materials are well formatted.
	38	The tutor's/instructor's contact details like their phone number, Telegram or Viber or What's up messengers, their email address are provided.
	39	All instructional materials that are posted can be opened using free and accessible software with the links to access that software or app.
Difficulty progression-based structure	40	The skills that are supposed to train are classified according to Bloom's Taxonomy.
	41	At the beginning of the course the assignments and activities are of reproductive type. At the end of the course the ones are aimed at generating content.
	42	The principles of self-paced learning and self-directed learning are found.
	43	The course design and materials incorporate different levels of mastery of the competencies.
A teacher-student (student-teacher) support and communication provision	44	The course builds learning community.
	45	Weekly online group meetings or discussions are supposed.
	46	The course uses gameplay design and mechanics to boost teacher-student or student-teacher communication.
	47	A teacher-student (student-teacher) support and communication is automated or semi-automated.
	48	The course tutor's expectations concerning the quality of student communications are clearly explained.
	49	The course tutor supposes to respond students' emails within 72 hours or less.
Variety of strategies for content delivery and student engagement	50	A variety of teaching techniques and methods are used to engage the student.
	51	Active learning environment is supposed to be created.
	52	Difficult terms and concepts are explained in more than one way.
	53	The variety of online tools are used to deliver the course and to facilitate students' in understanding the content and engagement.

	54	Students learning styles are considered when they are assigned with the activities.
	55	Discussions, projects, simulations collaborative learning are used to engage and motivate the students.
	56	Students' self-introduction, discussion postings with responses, providing project feedback are used as instructor(tutor)-learner communication strategy.
	57	Group discussion postings, group projects, peer reviews are used to maintain the learner-learner cooperation and communication.
	58	Essays, term papers, videos, self-assessments, readings are used to engage students with content.
	59	The dosing of study workload is considered.
Assessment	60	The module tests are found.
	61	The progress tests are found.
	62	Multiple types of assessments are frequently employed in the run of the course.
	63	The self-checklists for the assignments are found.
	64	Self- and peer cross evaluation is used.
	65	The course evaluation form is provided.
	66	The instructor's verbal or written feedback option is included.
	67	The summative assessment is ensured.
	68	Assigning performance tasks is applied.