Effect of creative and collaborative learning communities on virtual learning environment for Education 4.0: a quantitative study of Pakistan

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Abstract

Purpose – Education 4.0 is one of the major transformations in the field of education to improve the quality of teaching and learning processes and prepare students as 21st-century learners. This study aims to examine the effect of Education 4.0 on creative and collaborative learning of students.

Design/methodology/approach – In this correlational research study, a quantitative data collection tool such as a questionnaire is used. This research is conducted on university students (N = 365), and purposive sampling technique is used to achieve the purpose. Statistical Package for Social Sciences (SPSS) version 27.0 is used to analyze the data.

Findings – The findings of the study reveal that there is a strong positive relationship between education 4.0 and the two major 21st-century skills, i.e. collaboration and creativity. The value of correlation coefficient value of the variables is 0.597, which indicates positive and strong relationship; hence, null hypothesis is rejected and an alternative hypothesis is accepted.

Practical implications – The results of the current study are beneficial for the school managers to enhance students’ two significant 21st-century skills, i.e. “Creativity” and “Collaboration.” Also, the school managers can make efforts to develop teachers’ competence to adapt the technological advancements for improving students’ creativity and collaboration to benefit their learning.

Originality/value – This is a unique study because there are only a few recent studies that show a connection between Education 4.0 and 21st-century skills. Also, there is no other study that presents the direct association of Education 4.0 and students’ creativity and collaboration specifically in the context of Pakistan.

Keywords Learning communities, Education 4.0, Collaborative learning, Creative learning

Paper type Research paper

Introduction

In the last one and a half decade, the term “Education 4.0” has found relevance in almost every sphere of life which is based on Information and Technology (Miranda et al., 2021). Education 4.0 answers the queries which are posed by the Industrial revolution 4.0. The main feature of Industrial Revolution 4.0 is the merger between humans and technology to reach the viable solutions of underlying problems (Hussin, 2018). It is essential to understand the evolution process of Industrial Revolution 4.0 for the proper understanding of education 4.0 (Sharma, 2019). The first Industrial Revolution revolves around mechanize production. Second Industrial Revolution revolves around the electric power to produce mass production (Lawrence et al., 2019). Third Industrial Revolution brought shift from analog electronic technology to digital electronic technology. Fourth Industrial Revolution has brought the unprecedented advancements in the work settings of 21st century. Artificial intelligence, automation and robotics, the Internet of things, material sciences, biomedical engineering, nanotechnology, quantum computing etc. are some vivid features of Industrial Revolution 4.0 (Himmetoglu et al., 2021; Hussin, 2018). Industrial Revolution 4.0 has not only influenced the business and commercial activities, but also affected educational activities. Thus, catering
the needs of education, the Industrial Revolution 4.0 has transformed into education 4.0 in educational context and settings (Hussin, 2018). Education 4.0 has redefined the role of the learners and teachers. Every stakeholder of the educational process whether learners, teachers, parents or leadership, each one has to be equipped with modernized technological practices (Himmetoglu et al., 2021). Teaching process has become more enriched by giving positive feedback to the learners that helps them improve their learning by using technological based platforms.

With the rapid changes in the today’s complex modern world, there is a great pressure on educational institutions to provide education which may foster 21st-century skills in future leaders. One of the dominant 21st-century skills is collaboration that improves not only the academic achievement of the learners, but also improves their social well-being (Ginsburg-Block et al., 2006). Education 4.0 helps in creating virtual learning environment that involves students in collaboration and results in productive and positive learning outcomes. Another significant 21st-century skill is creativity that is considered as an essential part of learner’s psychology and holistic educational development (Beghetto and James, 2014; Davies et al., 2013).

The multiple benefits of Education 4.0 and of two major 21st-century skills, i.e. creativity and collaboration tend to conduct this research study that aims to examine the effect of Education 4.0 on collaborative and creative learning of the learners. Following are the research questions of this study.

**RQ1.** To what extent Education 4.0 is useful in collaborative and creative learning of the learners?

**RQ2.** Is there any relationship between Education 4.0 and collaborative and creative learning of the learners?

The introduction section follows the literature review, methodology, results and analysis, discussion along with conclusion that includes academic or theoretical contribution, managerial implications, limitations and future recommendations.

**Literature review**
The review of the seminal studies about Education 4.0 and two major 21st-century skills, i.e. creativity and collaboration comprises theoretical background, hypothesis development and conceptual framework in order to present systematic discussion of concept.

**Theoretical background**
The theoretical background of the study shows discussion about diversified ideas about Education 4.0 and 21st-century skills that mainly include creativity and collaboration as dependent variables of the study. The theoretical background of this study consists of teaching and learning communities in the digital age, transition from Education 1.0 to Education 4.0, creative and collaborative learning in virtual environment.

**Teaching and learning communities in the digital age**
Digital age has revolutionized the education process. It has offered benefits to all the stakeholders particularly teachers and learners (Sharma, 2019). Today, in the digital age, technology allows the teachers to set the tasks as per the need of learners by using various online learning application software (Suh, 2011). Therefore, this digital era demands from teachers to develop 21st-century skills in the learners so that they can contribute positively in a practical world (Pineida, 2011). Thus, the advancement in the digital technologies in 21st
century has brought tremendous change in the role of a teacher. In the digital age, the learners have more access to information outside the classroom settings by utilizing various technology based learning tools. However, not all the knowledge available on these platforms is pertinent to the learners’ needs. Thus, teacher’s role has restructured from knowledge provider in the past to knowledge designer in the digital era (Garba et al., 2015). Suitable and conducive digital learning environment can sharpen their individual skills by involving them in the learning process that best suits to their needs.

**Transition from Education 1.0 to Education 4.0**

World witnessed the first Industrial revolution in the latter half of 18th century in Europe. With the growth of industrial sector, education sector also expanded in terms of growth and development that was the beginning of Education 1.0 (Miranda et al., 2021). The shifting from manual to mechanized practices gave birth to paper making machine and mechanical printing (Valentín et al., 2013). During that era, educational practices were based on the philosophy of objectivism mainly focusing on the role of teacher (Fosnot, 2013). Teacher was considered as the sole authority to the knowledge. With the start of 20th century, industrial revolution 2.0 also influenced education sector that brought further technological advancements in education sector where the role of teacher was still quite active in education 2.0. Later on, Industrial revolution 3.0 was dominated by computer based knowledge, automation and new technological advancements in educational settings. The teaching-learning processes were assisted by varied resources such as multimedia, online learning tools and virtual settings for teaching and learning (Miranda et al., 2021). The main features of the technological advancement of industrial revolution 4.0 are artificial intelligence, Internet of things, Robotics, quantum computing, nanotechnology (Hussin, 2018) etc. Smart technologies have become the main feature of academic practices which are the very features of Education 4.0. Students can construct their knowledge by using various software which may also help them to improve their creativity and critical thinking skills (Luciana, 2020; McKnight et al., 2016; Sharma, 2019).

**Creative learning in virtual environment**

Creativity is needed as an essential 21st-century skill that is mandatory for future professions (Beghetto and James, 2014). In the current era of technology, creativity is considered as an important component for developing the learners as digitally literate beings. The world is not only focusing to develop child cognitively but also digitally. Figure 1 depicts Digital Bloom’s Taxonomy is the classification of educational levels to develop students’ digital skills (Sneed, 2016). Its purpose is to make teachers aware of multiple technological tools and resources to facilitate students’ learning. At each level, students develop and enhance digital skills that help them to move to the next levels of digital learning.

In addition, results-investigation-student-environment (RISE) framework is being considered in Australia that comprises four interlinked elements such as results, investigation, student and environment (Figure 2). Among these four components, results are the end products that are aimed to be achieved. These results could be in the form of students’ learning and other intended outcomes (Richardson and Mishra, 2018). In the process of investigation, creative-thinking skills are significant to support the process of developing students’ creativity.

Another theory of creativity is componential theory of creativity (Amabile, 2018) that comprises three components of creative behavior that are expertise, creative-thinking skills and intrinsic motivation. In this model, expertise includes individual’s technical, procedural and...
Figure 1.
Bloom's digital taxonomy

Source(s): Sneed, 2016

Figure 2.
Rise framework
(Cropley and Patston, 2019)

Source(s): Cropley and Patston, 2019
intellectual knowledge. Creative thinking is one's ability to think uniquely and artistically. Along with them, the intrinsic motivation is the one's internal drive to solve a query.

**Collaborative learning communities in virtual environment**

In the current era, technological ridden advanced approaches are diffusing in every segment of life with faster pace. In educational institutions, technology has converted the role of educators from sage to facilitator and the role of learners from passive to active learner (Roselli, 2016). Today’s learners prefer to interact with their peers by using social media platform. They usually become more interactive, socially attached and quite active when they use online platform and digital technologies (Williams et al., 2015). If collaborative learning approach integrates with virtual environment, learners can quite actively involve in learning process and serve their learning needs in an effective way (Williams et al., 2015).

**Online collaborative learning model**

Modern learning approaches are prone towards constructivist learning approach in which there is major focus on utilizing digital technologies. To enhance the learners’ achievements, online collaborative learning (OCL) model was given by Harasim (2017). Harasim (2017) argues that students are involved in mutual collaboration in order to solve problems through discussion rather than cramming correct answers.

Figure 3 presents the relationship between concepts, constructs and the proposition of OCL theory. The mentioned figure delineates the relationship between concepts, constructs and proposition of OCL theory. According to Harasim (2017), there are three phases of knowledge construction through discourse in a group: idea generating, idea organizing and intellectual union. At idea generating phase, individual students collaborate with one another in a group discussion to present its ideas regarding specific subject. Then comes the next phase, i.e. idea organizing where students may agree or disagree with the given ideas. After this segment, learners are usually in position to be subjected to the third phase of knowledge,
which is intellectual union. Learners actively engage to construct and synthesize the varied ideas which were discussed during group discussion.

Researchers suggest a few approaches to increase the effectiveness of OCL model. Firstly, the learning environment, which means the tools which are to utilize for collaborative learning. Rizal et al. (2022) suggests that interactive and collaborative learning can be more purposeful for the learners if it is coupled with flexibility and accessibility in terms of learning resources. Secondly, the learning design should contain the learning activities appropriate to OCL. Finally, OCL also provides suitable opportunities for interaction.

**Hypothesis of study**
In order to answer the research questions, following hypotheses were developed.

**Null Hypothesis:** There is no relationship between Education 4.0 and collaborative and creative learning of the learners.

**Alternative Hypothesis:** There is relationship between Education 4.0 and collaborative and creative learning of the learners.

**Conceptual framework**
There are various 21st-century skills that are essential to prepare students for this digital era. These skills include critical thinking/reasoning, creativity/creative thinking, problem solving, metacognition, collaboration, communication and global citizenship (Vivekanandan, 2019). Among all of them, the major two skills are creativity and collaboration that pave the path for the development of other skills too. That is why, this study considered these two 21st-century skills in order to analyze the effect of Education 4.0 on students’ learning.

One of the competencies of Education 4.0 is collaboration that is presented through collaborative learning model (Alammary, 2013). The collaborative model comprises 5 factors that ensure effective collaborative learning of students. Those factors include perceived readiness, collaborative tendency, access to technology, time constraint and guidance and support. Perceived readiness is considered as examining students’ preparedness to get engaged in online collaborative tasks. Collaborative tendency is students’ willingness to participate in online communication and knowledge sharing by using virtual learning tools. It is based on students’ own perception about significance and use of collaborative learning tools. Access to technology is also one of the major factors to support collaborative learning in educational sectors. It is required to arrange proper technical infrastructure that could support online collaboration. Time constraint is considered as the problem of virtual availability of all team members for active online collaboration. Another factor is instructional support and guidance that is pivotal for simplifying the learning process for students’ ease. It is essential for the teacher to share feedback and guide students to gain positive experience of collaborative learning.

Another competency is creativity that is reflected through creative learning model (Fan and Cai, 2022). Creativity is defined as individual’s ability to create new and useful ideas to resolve problems. This model of creativity comprises three components that include learning goal orientation, network ties and knowledge sharing. Learning goal orientation is individual’s motive of being involved in a task that is one of the major components of creative learning environment. Hence, the creative learning environment needs to provide more opportunities to students for making learning enjoyable experience. Another major component of creative learning environment is a network tie that aims to strengthen the social interaction in classroom. The positive network ties open ways for emotional attachment and social support that result in goal achievement in creative manner. Moreover, knowledge sharing is the
process of sharing knowledge among individuals by developing supportive relationships. This process of sharing knowledge familiarizes with diverse knowledge, paves path to refine old set of knowledge and generate new one by utilizing collective wisdom. The conceptual framework of study is shown in Figure 4.

Methodology
The research methodology comprises research method and research design. Additionally, it includes sampling and sampling procedure along with tool development process. Also, it presents data analysis procedure that includes the steps that were followed to reach to the results. This research study aimed to examine the effect of education 4.0 on creative and collaborative learning of learners. Therefore, it is needed to collect empirical evidence to explicate the effect of an independent variable (education 4.0) on dependent variables (creative and collaborative learning). To analyze the data, the deductive approach is considered that first formulates a hypothesis that would be either accepted or rejected based on the statistical analysis. This research study employed the use of quantitative data collection tool such as questionnaire that helped to collect appropriate and authentic data and analyze it to examine the effect of education 4.0 on creative and collaborative learning of learners.

Research design
This research study follows correlational research design that aims to observe two variables in order to examine a statistically corresponding relationship between them. Based on the data collection method, survey research is one of the types of correlational research design. In this

![Figure 4. Conceptual framework of study](image-url)

Source(s): Authors’ own creation/work
type of research, the respondents are randomly sampled and are asked to fill a questionnaire focused on the research area that facilitates large scale data collection in less time (Troy et al., 2021).

Whereas, this research is conducted on university students ($N = 365$) who have completed their 16 years education and are enrolled in Master’s Program in one public university of Sindh, Pakistan based on convenience as the researcher belongs to the same university. In addition, purposive sampling technique was used to deliberately choose participants in order to gain great deal of information (Etikan and Bala, 2017). This type of sampling was used to fill the literature gap as no such study has been conducted on postgraduate students mainly focusing on this area of research. To sample respondents, the criteria was set; respondents must be enrolled in Master’s Program, must include both gender and their age must be above 23 years. These criteria were chosen because there was no such study that was conducted on postgraduate students or on mentioned age group participants. Additionally, male as well as female participants were preferred in order to get diverse point of view from both gender.

**Tool development procedure**

This process of tool development includes the rigorous and quality process to review and evaluate data collection tools available in literature. The conceptual framework was the main helping source that facilitated the designing of survey tool. The questionnaire comprises two major sections. Section A includes respondents’ demographic information and section B comprises 2 constructs that are Collaborative Learning with Education 4.0 and Creative Learning with Education 4.0. The first construct “Collaborative Learning with Education 4.0” comprises 5 factors that ensure effective collaborative learning of students (Alammary, 2013). Each of these factors has two items as part of this construct that make 10 items in total. Another competency is creativity that is reflected through creative learning model (Fan and Cai, 2022). Each of these components includes 3 items as a part of second construct making 9 items altogether. Collectively, section B comprises 19 items that aim to examine the effect of education 4.0 on learners’ collaborative and creative learning. Respondents were asked to mark their responses on 5-point Likert scale that ranges from strongly agree to strongly disagree. In Likert scale, strongly agree stood on 5 number whereas strongly disagree stood at 1. After development of questionnaire, it was shared with two experts that include content expert and language expert to check the validity of the data collection tool. Both of them marked the validity against the validity criteria. Validator marked the validity of each of the items in order to improve the questionnaire. Also, exploratory factor analysis (EFA) was administered to know the validity of the tool. After running EFA, few items were removed due to lower factor loadings. In order to check the reliability of the questionnaire, the reliability test was conducted that depicted Cronbach’s Alpha value = 0.892 that is considered good as per reliability scale.

**Data analysis procedure**

To analyze the data, SPSS version 27.0 was used and normality test was conducted to find the distribution of data and selection of the statistical test accordingly. According to the results of normality analysis, data were not normally distributed; therefore, non-parametric correlational statistical analysis (Spearman Correlation) test has been used along with the descriptive statistics.

**Findings and analysis**

The data was collected by using a questionnaire that comprises one independent (education 4.0) and two dependent variables (creative and collaborative learning). It encompasses 19
items out of which 10 items are in first variable and 9 items in second variable. Table 1 shows total 365 students including 180 males and 185 females and their age ranges from 23 to 42 years.

In order to answer the first question “To what extent Education 4.0 is useful in collaborative and creative learning of the learners?” the mean score of each item of both constructs was compared against the table of mean specification.

Effect of Education 4.0 on students’ collaborative learning
The respondents’ responses about effect of Education 4.0 on students’ collaborative learning comprise 10 items. As per the collected data from 365 respondents, there was acceptable mean score observed in the effect of Education 4.0 on students’ collaborative learning. More specifically, students’ readiness for their participation in online collaborative task and effectiveness of OCL depending of their basic technological skills are the primary areas to be considered. Students’ willingness to communicate online is also important for successful online collaboration. In addition, teacher’s support for simplifying online tasks for students helps to create ease in online collaborative tasks and provision of teacher’s feedback in collaborative tasks carry very high-level mean score as per the table of mean specification (Arrieta, 2020). Moreover, the availability of technological infrastructure in educational institutions for online collaboration, learners’ access to technological tools for effective virtual collaboration and the online unavailability of all learners at the same time as a challenge for online collaboration have mean score 4.11, 4.17 and 4.05 respectively that is also acceptable and considered under high range mean score as per the mean specification table as shown in Table 2 (Arrieta, 2020). The overall mean score suggests that availability of all components of Education 4.0 is essential for developing students’ collaborative learning.

Effect of Education 4.0 on students’ creative learning
Table 3 shows the normality analysis by conducting Shapiro–Wilk test. The respondents include males as well as females. The normality analysis depicts that the value of effect of Education 4.0 on students’ creative and collaborative learning among males was 0.02 and 0.03 among females that is less than 0.05 showing that data in not normally distributed. That is why, non-parametric test, i.e. Spearman’s correlation test was conducted.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic qualification</td>
<td>180</td>
<td>185</td>
</tr>
<tr>
<td>Enrolled in master’s program</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>From 23 to 42 years</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source(s): Authors’ own creation/work

<table>
<thead>
<tr>
<th>Range value</th>
<th>Verbal interpretation</th>
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<tr>
<td>4.50–5.00</td>
<td>Highly acceptable</td>
</tr>
<tr>
<td>3.50–4.49</td>
<td>Acceptable</td>
</tr>
<tr>
<td>2.50–3.49</td>
<td>Moderately acceptable</td>
</tr>
<tr>
<td>1.50–2.49</td>
<td>Fairly acceptable</td>
</tr>
<tr>
<td>1.00–1.49</td>
<td>Not acceptable</td>
</tr>
</tbody>
</table>

Source(s): Arrieta (2020)
The respondents’ responses about effect of Education 4.0 on students’ creative learning that comprises 9 items. All of these 9 items reflect the relation of the components of Education 4.0 with creativity of the students as a 21st-century skill. According to the descriptive results, the use of educational technology as enjoyable experience for learners carries mean score of 4.28 that is considered under very high-level mean score as per the table of mean specification (Arrieta, 2020). In addition, there was acceptable mean score obtained for use of online learning for learner’s technological skills, use of educational technology to improve communication skills of learners and to increase collaboration and social competence among learners. Also, the integration of technology to facilitate interaction between teacher and learners, to develop social emotional skills of learners, to refine students’ old ideas and create new one, to improve mental capacity of learners as compared to learning in traditional classroom and to offer diverse set learning experiences to all learners carry mean score that is considered under high range mean score. Whereas, the cumulative mean of both variables as shown in Table 4 i.e. collaborative and creative learning that is 4.27 and 4.02 that is considered under high range mean value as per Table 2 of mean specification (Arrieta, 2020).

In order to respond to the second question of the study “Is there any relationship between Education 4.0 and collaborative and creative learning of the learners?” the relationship between Education 4.0 and collaborative and creative learning of the learners was found by running Spearman’s Correlation test was conducted to examine the strength of relationship between the dependent (collaborative and creative learning of the learners) and independent variables (Education 4.0). Table 5 indicates that the value of Correlation coefficient, to specify the effect of

<table>
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<tr>
<th>Tests of normality</th>
<th>Participants</th>
<th>Kolmogorov–Smirnov Statistic</th>
<th>Shapiro–Wilk Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effect of Education 4.0 on students’ creative and collaborative learning</td>
<td>Male</td>
<td>0.274</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>0.138</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Table 3. Normality analysis

| Collaborative learning | 365 | 4.2723 | 0.48846 |
| Creative learning | 365 | 4.0245 | 0.49752 |
| Valid N (listwise) | 364 |

Table 4. Descriptive analysis

| Spearman’s rho | Creative learning for Education 4.0 | Correlation coefficient N (2-tailed) | Creativity | Collaboration |
| | | 1.000 | 0.597** | 0.000 | 1.000 |
| | | 365 | 365 |

Table 5. Results of spearman correlations

Source(s): Authors’ own creation/work
technology infused education 4.0 on students’ collaborative and creative learning, which is 0.597 that indicates positive and strong relationship between both the targeted variables. In the light of the test result, null hypothesis is rejected and alternative hypothesis is accepted.

**Discussion**

This section presents the discussion of research findings as related to the literature on effect of Education 4.0 on collaborative and creative learning of the learners. There are few research studies that indicated similar findings and strengthen this notion that technology has positive influence on developing students’ diversified skills. In Jordan, Bani Salameh et al. (2017) conducted a research study which concluded that technology interaction tends to support students’ learning by developing their quest to interact with others in online 3D environment. Beghetto and James (2014) conducted another study that indicated the similar findings that if teachers provide students opportunities to think and work creatively using the technological tools, it can lead them to avail themselves the benefits of education 4.0 for students’ creativity development. Another survey study also had similar results when the researcher incorporated collaborative strategies on post graduate students but on smaller scale (Williams et al., 2015). In addition, Rusdin (2018) concluded that teachers’ readiness is essential in implementing 21st-century learning for improving students’ academic level and level of understanding 21st-century learning skills; therefore, there is need to improve teachers’ understanding, knowledge and skills related to their teaching and technology that could help to improve students’ learning. All of these studies represent the similar findings of usefulness of Education 4.0 to develop collaboration and creativity among students. The consistency in findings of the research studies prove that once collaborative and creative learning opportunities are integrated with technology, they permit more interaction and communication than traditional method of learning.

In this study, we find that students’ readiness for their participation in online collaborative task is one of the essential elements that increase the effectiveness of OCL. It also indicates that students’ willingness and teachers’ guidance to communicate online is also important for successful online collaboration (Saykili, 2019). Along with this, the educational institutions must be equipped with technological infrastructure for online collaboration to make it accessible for learners (Alammary, 2013).

On the other hand, few studies found contrary results such as Miranda et al. (2021) conducted a research study that highlights the notion of restricted teacher-students face to face interaction; therefore, students rarely share their problems with teachers. This lack of teacher-student face to face interaction may lead to communication gap which in turn results in the teaching and learning gap. If there are benefits of integrating components of Education 4.0, it also shows few dark aspects. Therefore, the comparison of this study with other previously conducted studies raises questions and requires further exploration of the context, teaching content, grade level. The issue of the use of education 4.0 to improve students’ collaboration and creativity may be debatable but there is agreement that there is need to improve these two essential 21st-century skills of the students to prepare them for digital era.

The results of this study prove the significance of education 4.0 for developing students’ creative and collaborative learning that is only possible when teachers are capable of utilizing technological resources and plan collaborative and creative learning activities that have potential to enhance students’ collaborative skills, improve their social competence and develop creativity (Davies et al., 2013). In the light of comparison between the findings of this study and previously conducted studies, the practitioners need to align their teaching with technologically integrated collaborative and creative learning opportunities. Also, they need to engage learners in online individual and group tasks in order to enhance their collaboration and creativity (Herrera-Pavo, 2021; Songkram, 2015).
Conclusion
To conclude, this research study aimed to examine the effect of education 4.0 on collaborative and creative learning of university students. In Pakistan, teacher-centered method restricts learners’ capabilities to participate confidently and interact positively with peers. Such educational practices depict the lack of students’ collaboration and creativity that are among essential 21st-century skills. However, Education 4.0 has become quite successful in creating virtual learning environment that involves students in collaboration and helps to develop their creativity.

Academic/theoretical contribution
Information and communication technology (ICT) has opened new opportunities for the range of OCL activities that have potential to enhance students’ collaborative skills and develop their creativity. The research study suggests few recommendations that could be considered to integrate Education 4.0 to enhance students’ collaboration and creativity that would lead to improve teaching and learning contributing to quality education.

Managerial implications
The findings of the study are helpful for the school managers in order to realize the importance of Education 4.0 to enhance two significant 21st-century skills, i.e. creativity and collaboration. If they realize their importance, they will focus more on involving teachers in professional learning that could enable them to integrate technology for development of students’ creativity and collaboration. Also, the school managers can keep an eye of teachers’ competence to adapt the technological advancements for improving students’ creativity and collaboration to ultimately benefit their learning.

Limitations and future recommendations
This study was conducted on only one university of Sindh that is why its findings cannot be generalized. Also, this study employed quantitative research design that lacked in-depth exploration of the research area. There is no doubt that there is dearth of practicing technologically integrated teaching-learning practices that can develop students’ interest, motivation and inclination towards their learning mainly focusing on students’ collaborative and creative learning skills. Hence, there are some recommendations for practitioners, policy and future researchers in the light of this research study.

This research study is the evidence of examining the effect of education 4.0 on collaborative and creative skills of university students. Therefore, I suggest teachers and practitioners to adapt their teaching methodologies and align them with technologically integrated collaborative and creative learning opportunities.

In the light the research study, there are some recommendations for policy makers generally and for higher education particularly. The existing curriculum or course guide of all disciplines should be reexamined to augment the aspects of Education 4.0. For pre-service teachers, it is necessary to include course of Education 4.0 in professional degree of teacher’s preparation programs. It will help to enable teachers to develop students’ skills as per need of technological era. For in-service teachers, different professional development programs should be initiated to familiarize them with online teaching and learning strategies.

In addition, there are few recommendations for the future researchers to conduct study on Education 4.0. They can examine the extent to which schools’ or universities’ teaching practices are reflecting use of technology mainly focusing on the aspects of education 4.0. It will help them to examine the level of teachers’ awareness and pedagogical skills to implement Education 4.0 as essential teaching approach. On the basis of such study, in-service teachers’ professional development program can be planned by using Education 4.0 framework. They can also
They can explore effects of Education 4.0 on students’ achievement, motivation or other 21st-century skills. They can also compare effect of Education 4.0 on students of public or private educational institutions.

References


Further reading

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