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Observance of 21st century skills teaching practices and its impact on academic performance

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Abstract

The study aimed to determine observance of teaching practices on 21st century skills and to what extent these practices impact on students' academic performance. A descriptive-survey research method was employed. Forty-five randomly selected education student completers of a major subject in teaching strategies in a state university participated in the investigation. Results revealed that teaching practices of teachers on critical thinking and collaboration skills were observed one-to-three times per week whereas those on communication and creativity & innovative skills were observed one-to-three times per month. Academic performance is significantly related pairwise with critical thinking, collaboration, communication, and creativity & innovative skills, respectively. Collaboration, communication, and creativity & innovative skills, taken singly, are not significant predictors of academic performance. Taken in combination, observance of teaching practices on collaboration, communication, and creativity & innovative skills can significantly predict students' academic performance. Engaged and improved learning involving these skills resulted in good academic performance. Students' achievements then should be extended to incorporate the 21st CS that the students are expected to acquire.

Introduction

Changes in society and the economy due to rapid development in science and technology, and transformations in labor market attributes are important driving forces that call for 21st century skills (21st CS) (Global Partnership for Education [GPE], 2020). The 21st CS is defined as "the skills, knowledge and expertise students must master to succeed in work and life" (Partnership for 21st Century Skills, 2009). The teaching of 21st CS aims to make students' learning more relevant and responsive (Lavi et al., 2021). Educators, therefore, have a civic and academic obligation to equip students with these skills (Gündüz & Akkoyunlu, 2019; Khoiri et al., 2021).

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Teacher education programs must be the first to begin this practice by assisting education students to explore and reflect on these skills and integrate them in their field service activities (Valtonen et al., 2021). This fact is more significant for education students as they themselves, in turn, will assume responsibility of developing these skills to their future students (Shidiq & Yamtinah, 2019).

In response to the needs of the times, the 21st CS are emphasized in different countries' national educational goals (Niu et al., 2021; Afandi et al., 2019). Integration of the 21st CS in the basic education curriculum is the primordial strategy of the states to make teaching-learning process responsive to the needs of the period (Makmee, 2021). However, the role of such skills is much weaker in terms of actual teaching practices (Gelmez Burakgazi et al., 2019). Existing literature reveals a less than satisfactory result for studies conducted for 21st CS teaching (Chu, et al., 2021; Urbani et al., 2017). This is a serious concern as teachers trained under the old teaching model do not possess the necessary skills to establish a learning environment for the students to acquire the 21st CS (Bedir, 2019). Because these skills have become an important issue throughout the world, according to Haviz et al. (2020), research studies of these skills from various perspectives and important fields are to be carried out.

The current study fills the gap in the teacher education literature as it primarily examined observance of 21st CS teaching practices focusing on critical thinking, collaboration, communication, and creativity & innovative skills. Specifically, the following research questions were addressed: To what extent are the 21st CS teaching practices on critical thinking, communication, collaboration, and creativity & innovative skills observed? How predictive, taken singly or in combination, are the 21st CS teaching practices of the academic performance of the education students?

Literature Reviews

Teachers must acquire 21st CS that will enable them to transfer these skills to their students (Gonzales, 2018; Kayange & Msisk, 2016). This is in line with Cognitive Apprenticeship Theory (Collins et al., 1987). It underscores the significance of processes in which an expert of skill coaches that skill to an intern. The said theory concentrates on teaching approaches that include modelling, scaffolding, coaching, articulation, exploration, and reflection. Hence, it applies to teacher education programs (Urbani et al., 2017). The concept is supported by Bandura's (1997) Theory of Modelling, which posits that the mentee must focus on the information presented for modelling to succeed. He must have access to the information and retain it. With motivation to learn, he must be able to correctly replicate the desired skill.

As there are many skills under the 21st CS, the Partnership for 21st Century Skills presented the 4Cs of critical thinking, communication, collaboration, and creativity & innovation as the super skills in the 21st century (Kivunja, 2015). They are essential to succeed in college, profession, and life outside academic institutions (Samsudin et al., 2018). Ravitz (2014) defined critical thinking as the competence to interpret, evaluate, analyse, synthesize, and summarize information. In the same manner, the goal of teaching, according to Boa et al. (2018), is to enable students to reason out, evaluate, understand how to solve problems, and utilize these skills in real world settings. Collaboration skills, on the other hand, pertain to being able to work effectively and be respectful of one another in groups; solving problems or answering questions together; willingly accept shared responsibility in completing a task; and recognize individual contributions by each member (Ravitz, 2014). Teachers promote collaboration in classrooms by facilitating group and team works where there is involvement of cooperation.

Communication skills pertain to the ability of organizing points of view, facts, and results and share these efficiently, written or orally, via a diversity of media (Ravitz, 2014). To assist the students, the teacher may use multiple communication strategies, facilitating interaction among students in groups, and involving students to collaborate in class projects. Voogt et al. (2013) declared that teachers should be aware of different pedagogical strategies to make the most of ICT and sustain the improvement of, not only collaborative and communication skills of students, but likewise the rest of 21st CS.

Creativity & innovative skills, as defined by Ravitz (2014), concern the ability to produce and improve solutions to complicated problems or undertakings centred on synthesis, analysis, and consequently organize what they learned in novel and original ways. In classroom situations, the teacher may conduct activities to encourage students to be imaginative and creative and enable them to articulate their own ideas in addition to their development of deeper insights of the situations (Valli et al., 2014).

Conceptual Framework

Figure 1 below shows the conceptual framework of this study which consists of 21st century skills teaching practices as independent variables and academic performance of education students as the dependent variable. The intent of the study was to determine the impact of teaching practices dwelling on critical thinking, collaboration, communication, and creativity & innovative skills on students' academic performance.

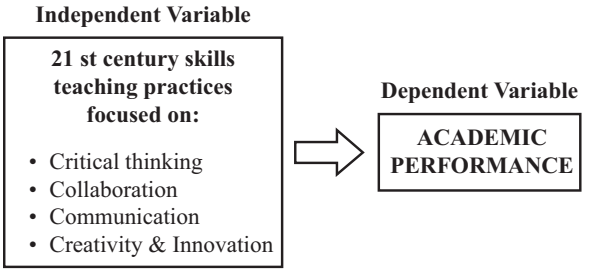

Figure 1 Conceptual framework

Methodology

The study utilized the descriptive method of research as it showed what exactly transpired in the investigation. It intended to determine the teachers' observance of teaching practices in developing the 21st CS among education students in a provincial branch of a Philippine state university. Forty-five (45) out of 50 student completers of an education major subject in teaching strategies willingly responded to the questionnaire. They were selected using the simple random sampling technique. The Slovin's formula determined the sample size at .05 margin of error.

Data Collection and Instrument

The data were collected from the response of the students via Google Form. The study principally used a questionnaire, which was the main data-gathering instrument. It was adopted from West Virginia 21st Century Teaching and Learning Survey [WVDE-CIS-28] (Ravitz, 2014). The current study simply focused on four out of the original eight dimensions. They comprise the critical four Cs – abbreviated as 4Cs. The four dimensions with their corresponding reliability factors in parentheses were critical thinking skills (.90), collaboration skills (.94), communication skills (.93), and creativity & innovation skills (.94). Three expert educators from the said state university confirmed the face validity of the instrument. The survey asked about the observance frequency of teaching practices pertaining to development of 21st CS. Interpretations for computed means were based on the following five-point Likert scaling: 4.200–5.000, Almost Daily (AD); 3.400–4.199, 1–3 Times per Week (OTTPW); 2.600–3.399, 1–3 Times per Month (OTTPM); 1.800–2.599, A Few Times a Semester (FTS); 1.000–1.799, Almost Never (AN). The education teacher of the major subject in teaching strategies provided the final grades of the selected education students.

Data Analysis

The collected data were consolidated and tallied in a spreadsheet and consequently subjected to computations with the use of a statistical software. The five-point Likert scale was applied to lend the data for statistical analysis and present verbal interpretations. The simple mean and standard deviation were the main descriptive statistics worked out. A multiple-regression analysis at .05 level of significance was performed with a purpose of establishing the predictive ability of 21st CS teaching practices focused on critical thinking, collaboration, communication, and creativity & innovative skills on the academic performance of the education students. Regression analysis is more flexible than any other relational analyses (Frost, 2021). It can estimate the effect of changing one independent variable on a dependent variable while holding all the other independent variables constant. The procedure enables one to determine the influence of each independent variable and not to worry about other variables in the model.

Assumptions of Multiple Linear Regression

Conducting a multiple regression analysis necessitates meeting of several assumptions, some of which were considered in the study, namely, normality, linearity, homoscedasticity, absence of multicollinearity, and independence of errors (Field, 2009; Statistics Solutions, 2021). In performing the data analysis, these assumptions were satisfied and established in the study.

Figure 2 shows the normal distribution of residuals (i.e. differences between observed value of the dependent variable and the predicted value) as they go along the diagonal normality line in the generated normal Predicted Probability plot of the study. Figure 3 indicates the homoscedasticity of the residuals as they are randomly distributed.

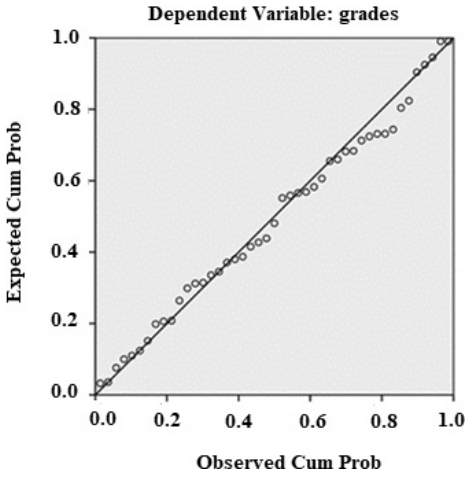

Figure 2 Normal P-P Plot of Regression Standardized Residual

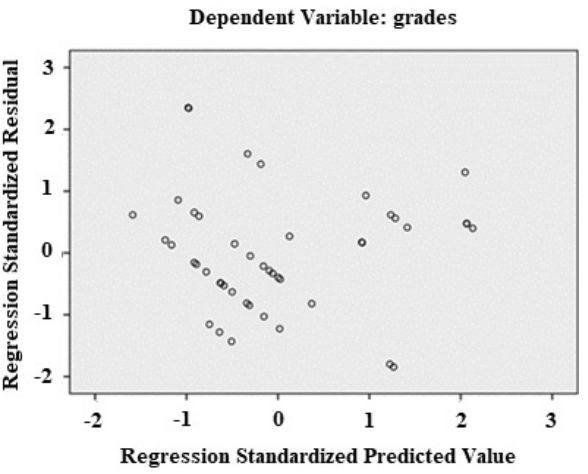

Figure 3 Scatterplot

If the residuals are normally distributed and homoscedastic, it follows that the residuals are linear (Statistics Solutions, 2021) and such was the case in the study. Multicollinearity refers to when the predictor variables are highly correlated with one another. If it exists, according to Field (2009), the regression model will not be able to accurately associate variance in the outcome variable with the correct predictor variable, leading to muddled results and incorrect inferences. Absence of multicollinearity is established if the variance inflation factor values (VIF) in the data analysis are below 10.00. VIF values for the four predictor variables of the study were all below 5.00 (i.e., critical thinking, 3.150; collaboration, 4.026; communication, 3.353; and creativity & innovative skills, 4.316). Finally, the Durbin–Watson test checks whether the residuals (errors) in the model are independent or not. As a conservative rule of thumb, values closer to 2 indicate such independence. In this case, the conducted data analysis generated a Durbin-Watson value of 1.493.

Results

Table 1 shows the observance frequency of teaching practices on 21st century skills. Teaching practices on critical thinking and collaboration skills were observed one-to-three times per week (OTTPW). Teaching practices on communication and creativity & innovative skills were one-notch-lower observed one-to-three times per month (OTTPM).

The results of the analyses, as shown in Table 2 below, showed that academic performance is significantly correlated pairwise with critical thinking, collaboration, communication, and creativity & innovative skills, respectively, as indicated by $p < .01$ levels (2-tailed). With all Pearson coefficient $r > .50$, academic performance is highly correlated with critical thinking (.609); collaboration skills (.724); communication skills (.665); and creativity & innovation (.714).

Table 1 Observance frequency of teaching practices on 21st century skills

21st Century Skills	*M*	*SD*	Verbal Interpretation
1. Critical Thinking	3.497	0.832	OTTPW
2. Collaboration Skills	3.459	0.932	OTTPW
3. Communication Skills	3.391	0.898	OTTPM
4. Creativity & innovative skills	3.231	0.913	OTTPM

Note: M – Mean Score; *SD* – Standard Deviation; *Scale:* 4.200–5.000, Almost Daily (AD); 3.400–4.199, 1–3 Times per Week (OTTPW); 2.600–3.399, 1-3 Times per Month (OTTPM); 1.800–2.599, A Few Times a Semester (FTS); 1.000–1.799, Almost Never (AN).

Table 2 Bivariate correlations of academic performance with 21st century skills of critical thinking, collaboration, communication, and creativity & innovative skills

First Variable:	Second Variables:			
Academic Performance	Critical Thinking	Collaboration Skills	Communication Skills	Creativity & Innovation
Pearson Correlation	.609**	.724**	.665**	.714**
Sig. (2-tailed)	.000	.000	.000	.000
N	45	45	45	45

Note: ** Correlation is significant at the .01 level (2-tailed).

Table 3 reveals the results of multiple regression performed between 21st CS teaching practices and academic performance. Collaboration skills ($p > .05$), communication skills ($p > .05$), and creativity & innovative skills ($p > .05$). have all p-values greater than the level of significance.

Table 4 displays analysis of variance (ANOVA) table for multiple regression performed between 21st CS teaching practices and academic performance. The results of the regression analysis indicate a computed statistics $f = 18.649$ at a $p < .001$; Pearson coefficient R equals .760; coefficient of determination R^2 is equal to .577; and *Adjusted* $R^2 = .546$. The 57.7 percent of variance on academic performance is explained by the joint effects of collaboration skills, communication skills, and creativity & innovative skills.

Discussion

This study aimed to determine observance of teaching practices on 21st CS focused on critical thinking, collaboration, communication, and creativity & innovative skills. In developing critical thinking, the survey revealed that the teacher asked students to draw inferences based on facts and vital information; summarize what is read in their own words; and analyze solutions to situational problems one-to-three times per week (OTTPW). Less often observed than those mentioned, the teacher required students one-to-three times per month (OTTPM) to compare collected data from different sources in their homework; develop convincing positions in argumentations; and solve situational problems with more than one answer. Effective teaching of critical thinking, as Kivunja (2014) explained, helps students to think deeply and be aware of their own reasoning.

Collaboration skills involve a process by which students learn continuously from helping each other to performing task altogether to attain a shared end-goal (Sojayapan & Khlaisang, 2020). Results of the survey in the current study showed an education teacher observed teaching practices to develop collaborative skills among her students one-to-three times per week (OTTPW). These included creating small groups of students in completing tasks together; planning and setting goals for their respective teams; presenting their works to the class; giving feedback on other groups' works; and incorporating feedback from other groups.

Communication, as enunciated by Mishra and Kereluik (2011), "involves the ability to clearly articulate oneself through all mediums of communication, oral, written, and non-verbal media." This also includes effective use of digital media intended not only for communication but collaboration as well. As revealed in the current study, skills in communication among education students are advanced by their teacher through observing the following practices one-to-three times a month (OTTPM): asking students to convey concepts utilizing video, blogs, posters, and media other than a written paper; planning and performing oral presentations; responding to classmates' queries in front of the class; and making decisions on how they will show their work to the class.

Table 3 Multiple regression performed between 21st CS teaching practices and academic performance

Coefficient	β	*SE*	Standardized Beta	*t*-value	*p*
(Constant)	72.978	2.333		31.280	.000
Collaboration Skills	2.247	1.173	.373	1.917	.062
Communication Skills	.642	1.161	.103	0.553	.583
Creativity & innovative Skills	2.058	1.129	.335	1.823	.076

Note: Level of significance: $\alpha = .05$.

Table 4 Analysis of Variance (ANOVA) table for multiple regression performed between 21st CS teaching practices and academic performance

Sources of Variations	Sum of Squares	Degrees of Freedom	Mean Square	*f*-value	*p*
Regression	801.556	3	267.185	18.649	.000
Residual	587.422	41	14.327		
Total	1388.978	44			

Note: Dependent variable: academic performance, Predictors: creativity & innovative skills, communication skills, collaboration skills, $R = .760$; $R^2 = .577$; *Adjusted* $R^2 = .546$.

While "creativity," according to Fidan and Ozturk (2015), "is about the process of developing a new idea, invention or solution, innovativeness is about the process of implementing it." In incorporating creativity and innovative skills development in their instructions, the teacher in the current study observed the following practices one-to-three-times-per-month (OTTPM): requiring the education students to use idea generation methods like concept mapping and brainstorming; creating their own concepts on how to solve a problem; trying out diverse designs and exerting effort in improving them; creating a solution to an intricate problem; and generating a novel act to articulate thoughts.

In general, practices on developing the 21st CS focusing on critical thinking and collaboration skills among education students, as shown in Table 1, were done one-to-three times per week (OTTPW). Those for communication and creativity & innovative skills were observed one-to-three times per month (OTTPM). There may be differences in mean scores, however, these were slight. This demonstrates that the teacher gave education students ample chances to learn and put into practice the 21st CS. The results of the current study were almost the same as those of the study of Mirizon, Salim, and Elsyed (2020) wherein the majority of education teachers observed teaching practices on 21st CS one-to-three times per week (OTTPW). Laliberte and Gable (2014) affirmed that "frequent repetition, with reasonable time on task and dedicated practice will lead to mastery of skills." It can then be deduced that the teacher in the current study perceived the importance of practicing 21st CS in developing these skills among education students. This learning goal was partially attained in another region in the Philippines as can be seen in the results of the study of Molano (2020). In her study, 21st century skills teaching practices resulted in education students attaining good information and communications technology, creativity & innovation, and collaboration skills. However, their communicative, critical thinking, and problem-solving skills still needed improvement. The implementation of the K-12 Basic Education Curriculum in the country necessitates education graduates to possess the 21st century skills themselves so they can in turn develop them in their students (Department of Education, 2022).

As shown in Table 2, academic performance is significantly related pairwise with critical thinking, collaboration, communication, and creativity & innovative skills, respectively. In support of these findings, Bessick (2008) found out in her investigation that instruction in critical thinking, whether through direct teaching or independent study, is a factor that contributes to the improvement of students' academic achievement. Concerning collaboration and communication skills, Vrioni (2011) concurred that not only groups provide support for their members' learning, but likewise give motivation for them to attend and prepare for class, facilitate connectivity among students, and promote recognition that viable communication skills and interpersonal relationships are crucial to academic success. The study of Narayanan (2017) revealed that creative and innovative teaching practices enable students to understand the concept clearly, motivate the students to grasp the concept fully, establish deep retention of the concept in their memory and in the end, conclude that creativity & innovative skills and student academic performance have positive relationship.

Among possible combinations of 4Cs of the 21st CS, the combination of collaboration, communication, and creativity & innovative skills gave the highest predictive power on the academic performance. The results of multiple regression revealed that *p*-values corresponding to the individual predictive abilities of collaboration, communication, and creativity & innovative skills, as shown in Table 3, are all greater than .05 level of significance. Therefore, collaboration, communication, and creativity & innovative skills, taken singly, are not significant predictors of academic performance. However, the ANOVA table, in Table 4, indicates that the 21st CS teaching practices on collaboration, communication, and creativity & innovative skills, taken in combination, significantly predict the academic performance as indicated by $f(3,41) = 18.649$, $p < .001$. The regression model explained 57.7 percent of the variance in the academic performance. The most important factor based on the highest β coefficient of 2.247 is the collaboration skills. An average unit change of 2.247 in the academic performance is attained when there is a unit change in the average rating of collaboration skills.

In support of the findings, the study of Limna et al. (2022) had similar results in which creativity, collaboration, and communication learning greatly influence student performance, whereas critical thinking learning has no significant impact. Furthermore, education students in the study of Urbani et al. (2017) repeatedly commented that engaged and improved learning involving more than one aspect of the 21st CS resulted in their good academic performance. The students identified many advantages of collaboration and communication in small groups. They were able to develop creative lesson plan for a case study, present

content to their classmates via ICT, and communicate with parents, administrators, and other school personnel. Meanwhile, the study of Handajani and Pratiwi (2018) aimed to determine whether there were differences in the effect of applying Model Eliciting Activities (MEAs) that integrated 21st century skills versus conventional learning to learning outcomes. The result of the study showed that classes with MEAs gave better learning outcomes than the ones in conventional learning classes.

Conclusion and Recommendation

This study was conducted primarily to determine observance of 21st CS teaching practices and how they impact on students' academic performance. Teaching practices on critical thinking and collaboration skills were observed one-to-three times per week while those of communication and creativity & innovative skills were observed one-to-three times per month. Such frequency levels gave the education students sufficient opportunities to practice these skills and sustain these competences. Conducting bivariate correlations between academic performance and 21st CS teaching practices resulted in highly significant relationships between academic performance pairwise with critical thinking, collaboration, communication, and creativity & innovative skills. Regarding conducted multiple regression, the study established that collaboration, communication, and creativity & innovative skills, taken in combination, can significantly predict the academic performance of the students. Students' achievements, therefore, should be extended to incorporate the 21st CS that the students are expected to acquire. Education teachers may adopt best practices and strategies for engaging education students to develop the 21st century skills. These may entail alignment of lessons in the course syllabus along national higher education standards and objectives and relating real-life experiences to the content. This facilitates application of the 21st century skills in the actual field of work. Equally important, the school administration also plays a key role in providing a viable school environment that supports the development of teachers' capacity to teach 21st CS and foster education students' acquisition of these skills.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

Afandi, A., Sajidan, S., Akhyar, M., & Suryani, N. (2019). Development frameworks of the Indonesian partnership 21st-century skills standards for prospective science teachers: A Delphi Study. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 89–100. https://doi.org/10.15294/jpii.v8i1.11647

Bandura, A. (1977). *Social Learning Theory*. General Learning Press.

Bedir, H. (2019). Pre-service ELT teachers' beliefs and perceptions on 21st century learning and innovation skills (4Cs). *Journal of Language and Linguistic Studies*, *15*(1), 231–246. https://doi.org/10.17263/jlls.547718

Bessick, S. C. (2008). *Improved critical thinking skills as a result of direct instruction and their relationship to academic achievement*. [Unpublished doctoral dissertation]. Indiana University of Pennsylvania.

Boa, E. A., Wattanatorn, A., & Tagong, K. (2018). The development and validation of the Blended Socratic Method of Teaching (BSMT): An instructional model to enhance critical thinking skills of undergraduate business students. *Kasetsart Journal of Social Sciences*, *39*(1), 81–89. https://doi.org/10.1016/j.kjss.2018.01.001

Chu, S. K. W., Reynolds, R. B., Tavares, N. J., Notari, M., & Lee, C. W. Y. (2021). *21st Century skills development through inquiry-based learning from theory to practice*. Springer International Publishing.

Collins, A., Brown, J. S., & Newman, S. E. (1987). *Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics* (Technical Report No. 403). https://eric.ed.gov/?id=ED284181

Department of Education (2022). *K to 12 curriculum guide*. https://www.deped.gov.ph/k-to-12/about/k-to-12-basic-education-curriculum/

Fidan, T., & Oztürk, I. (2015). The relationship of the creativity of public and private school teachers to their intrinsic motivation and the school climate for innovation. *Procedia-Social and Behavioral Sciences*, *195*, 905–914. https://doi.org/10.1016/j.sbspro.2015.06.370

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed). SAGE Publications Ltd.

Frost, J. (2021). *When should I use regression analysis?* https://statisticsbyjim.com/regression/when-use-regression-analysis/

Gelmez Burakgazi, S., Karsantık, Y., Aktan, T., Ayaz, M. A., Büge, B. C., Karataş, F., Varol Şanlı, Ş., Tarım, B., & Yavaşca, O. (2019). Equipped or not? Investigating pre-service teachers' 21st century skills. *Asia Pacific Journal of Education*, *39*(4), 451–468. https://doi.org/10.1080/02188791.2019.1671803

Gonzales, J. B. (2018). Skilled teachers and resources towards the 21st century educational change: A theory development. *International Journal of Science and Engineering Investigations*, *7*(72), 77–78. https://www.researchgate.net/publication/339642773_Skilled_Teachers_and_Resources_Towards_the_21_st_Century_Educational_Change_a_Theory_Development

Global Partnership for Education [GPE] (2020). *21st Century Skills: What potential role for the global partnership for education? A Landscape Review*. Global Partnership for Education. https://www.globalpartnership.org/sites/default/files/document/file/2020-01-GPE-21-century-skills-report.pdf

Gündüz, A. Y., & Akkoyunlu, B. (2019). Student views on the use of flipped learning in higher education: A pilot study. *Education and Information Technologies*, *24*(4), 2391–2401. https://doi.org/10.1007/s10639-019-09881-8

Handajani, S., & Pratiwi, H. (2018). The 21st century skills with model eliciting activities on linear programs. *Journal of Physics: Conference Series*, *1008*(1), 012059. https://doi.org/10.1088/1742-6596/1008/1/012059

Haviz, M., Lufri, L., & Maris, I. M. (2020). Assessing prospective biology teachers (PBTs) perceptions on thinking as a 21st century skill: A case study at Islamic University. *Jurnal Pendidikan IPA Indonesia*, *9*(3), 319–329. https://doi.org/10.15294/jpii.v9i3.24077

Kayange, J. J., & Msiska, M. (2016). Teacher education in China: Training teachers for the 21st century. *The Online Journal of New Horizons in Education*, *6*(4), 204–210. https://www.semanticscholar.org/paper/TEACHER-EDUCATION-IN-CHINA%3A-TRAINING-TEACHERS-FOR-Kayange/5cc18209a8dec222881386b8fb756c60361bfce6

Khoiri, A., Komariah, N., Utami, R. T., Paramarta, V., & Sunarsi, D. (2021). 4Cs Analysis of 21st Century Skills-Based School Areas. *Journal of Physics: Conference Series, 1764*(1), 012142. https://doi.org/10.1088/1742-6596/1764/1/012142

Kivunja, C. (2014). Innovative pedagogies in higher education to become effective teachers of 21st century skills: Unpacking the learning and innovations skills domain of the new learning paradigm. *International Journal of Higher Education*, *3*(4), 37. https://doi.org/10.5430/ijhe.v3n4p37

Kivunja, C. (2015). Exploring the pedagogical meaning and implications of the 4Cs "super skills" for the 21st century through Bruner's 5E lenses of knowledge construction to improve pedagogies of the new learning paradigm. *Creative Education*, *6*, 224–239. https://doi.org/10.4236/ce.2015.62021

Laliberte, K. A., & Gable, R.K. (2014). *Inquiry-based instruction: Cultivating analytical habits of mind with 21st Century Skills: A quantitative approach*. Paper presented at the 45th Annual Meeting of the Northeastern Educational Research Association, Johnson & Wales University.

Lavi, R., Tal, M., & Dori, Y. J. (2021). Perceptions of STEM alumni and students on developing 21st century skills through methods of teaching and learning. *Studies in Educational Evaluation*, *70*, 101002. https://doi.org/10.1016/j.stueduc.2021.101002

Limna, P., Siripipatthanakul, S., Phayaphrom, B., & Siripipattanakul, S. (2022). The relationship between twenty-first-century learning model (4Cs), student satisfaction and student performance-effectiveness. *International Journal of Behavioral Analytics, 2*(1), 1–18. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4011953

Makmee, P. (2021). Development of learning and innovation skills assessment criteria for upper secondary school students: A multilevel confirmatory factor analysis using mixed-method design. *Kasetsart Journal of Social Sciences*, *42*(2), 319–324. https://doi.org/10.34044/j.kjss.2021.42.2.16

Mirizon, S., Salim, A. A., & Elsyed, Y. B. (2020). Preparing pre-service teachers for the 21st century education: A comparative study of two teacher education programs. In *International Conference on Progressive Education (ICOPE 2019)* (pp. 308–319). Atlantis Press. https://doi.org/10.2991/assehr.k.200323.141

Mishra, P., & Kereluik, K. (2011). What is 21st century learning? A review and a synthesis. In *Society for Information Technology & Teacher Education International Conference* (pp. 3301–3312). Association for the Advancement of Computing in Education (AACE).

Molano, T. C. (2020). The skills of pre-service teachers of region II, Philippines in the 21st century. *International Journal of Scientific and Technology Research*, *9*(2), 4108–4110. https://www.researchgate.net/publication/344840730_The_Skills_of_Pre-service_Teachers_of_Region_II_Philippines_in_the_21st_Century

Narayanan, S. (2017). A study on the relationship between creativity and innovation in teaching and Learning methods towards students academic performance at private higher education institution, Malaysia. *International Journal of Academic Research in Business and Social Sciences*, 7(4), 1–10. https://doi.org/10.6007/ijarbss/v7-i14/3647

Niu, S. J., Niemi, H., Harju, V., & Pehkonen, L. (2021). Finnish student teachers' perceptions of their development of 21st-century competences. *Journal of Education for Teaching*, *47*(5), 638–653. https://doi.org/10.1080/02607476.2021.1951602

Partnership for 21st Century Skills. (2009). *P21 framework definitions document*. http://www.21stcenturyskills.org/documents/p21_framework_definitions_052909.pdf

Ravitz, J. (2014). *A survey for measuring 21st century teaching and learning: West Virginia 21st century teaching and learning survey*. Office of Research, West Virginia Department of Education.

Samsudin, M. A., Zain, A. N. M., Jamali, S. M., & Ebrahim, N. A. (2018). Physics achievement in STEM PjBL: A Gender Study. *The Asia Pacific Journal of Educators and Education*, *32*, 21–28. https://doi.org/10.21315/apjee2017.32.2

Shidiq, A. S., & Yamtinah, S. (2019). Pre-service chemistry teachers' attitudes and attributes toward the twenty-first century skills. *Journal of Physics: Conference Series, 1157*(4), 042014. https://doi.org/10.1088/1742-6596/1157/4/042014

Sojayapan, C., & Khlaisang, J. (2020). The effect of a flipped classroom with online group investigation on students' team learning ability. *Kasetsart Journal of Social Sciences*, *41*(1), 28–33. https://doi.org/10.1016/j.kjss.2018.02.003

Statistics Solutions (2021). *Testing assumptions of linear regression in SPSS – Statistics solutions.* https://www.statisticssolutions.com/testing-assumptions-of-linear-regression-in-spss/

Urbani, J., Roshandel, S., Michaels, R., & Truesdell, E. (2017). Developing and modeling 21st-century skills with preservice teachers. *Teacher Education Quarterly*, *44*(4), 27. https://www.jstor.org/stable/90014088

Valli, P., Perkkilä, P., & Valli, R. (2014). Adult pre-service teachers applying 21st century skills in the practice. *Athens Journal of Education*, *1*. https://doi.org/10.30958/aje.1-2-2

Valtonen, T., Hoang, N., Sointu, E., Näykki, P., Virtanen, A., Pöysä-Tarhonen, J., Häkkinen, P., Järvelä, S., Mäkitalo, K., & Kukkonen, J. (2021). How pre-service teachers perceive their 21st-century skills and dispositions: A longitudinal perspective. *Computers in Human Behavior*, *116*, 106643. https://doi.org/10.1016/j.chb.2020.106643

Voogt, J., Fisser, P., Roblin, N., Tondeur, J., & Braakt, J. (2013). Technological pedagogical content knowledge - A review of literature. *Journal of Computer Assisted Learning*, *29*(2), 109–121. https://doi.org/10.1111/j.1365-2729.2012.00487.x

Vrioni, R. (2011). Effects of group learning on the academic performance of university students. *Problems of Education in the 21st Century*, *33*, 111–117. https://www.scientiasocialis.lt/pec/node/588