

Developing a 21st Century Technological Pedagogical Content Knowledge (TPACK) Instrument: Content Validity and Reliability

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Abstract

In teaching and learning today, technology plays an important role in the process. Teachers and students depend a lot on Information and Communication Technology (ICT) to teach and learn, especially since the Covid-19 pandemic happens all over the world. Nowadays, it is becoming more adamant for teachers to use technology in order to teach subject matters and at the same time they have to rely on it to develop the students' 21st century skills. Therefore, it is crucial for teachers to identify their TPACK level not only in teaching their subject matters, but also in teaching 21st century skills. A quantitative study was conducted to investigate secondary school English language teachers' TPACK in teaching 21st century skills in Selangor, Malaysia. This study developed an instrument to measure English language teachers' 21st century TPACK level in teaching 21st century skills by adapting from a previous study's instrument. The validation and reliability analyses were conducted accordingly. The validation process was conducted using the Content Validity Index (CVI) and Content Validity Coefficient (CVC) measures. To assess the reliability of the instrument, Cronbach's Alpha analysis was utilised. The CVI calculations showed that the I-CVI values ranged from 0.83 to 1.00 and the same was obtained for the CVC values. The Cronbach's Alpha value was also high, which was 0.966. The use of this instrument could help the immediate stakeholders to measure teachers' ability in teaching 21st century skills using technology and take proper actions for improvement.

Keywords: English language, instrument, teaching, TPACK, 21st century skills

1. Introduction

1.1 Background of Study

In the recent years, teaching and learning are no longer restricted within the four walls of a classroom. Nowadays, educators are encouraged to do blended learning, in which the teaching and learning processes are done interchangeably in a classroom and online learning. Online learning especially is done more frequent than before, especially since the pandemic of Covid-19 started. Schools and educational institutions are forced to close to ensure the safety and health of all parties and to prevent the virus from spreading uncontrollably (Harun, 2020).

Since teaching and learning sessions are conducted remotely through online distance learning, it has become a necessity for teachers and educators in Malaysia to learn how to teach with technology and gadgets such as laptops, computers, handphones, tablets, and others. This is the part where the knowledge to know how to utilize technology is crucial for teachers to have. Without the knowledge, it would be difficult for teachers to teach students remotely. In other words, teachers in schools need to have digital competence to teach, especially to cater to new challenges that might arise when teaching online (Miguel-Revilla et al., 2020). Teachers might encounter challenges to teach subject matters to the students, especially when in Malaysia, they are also required to teach 21st century skills to the students as well (Shafie et al., 2021).

To teach effectively in the 21st century, a teacher is required to be an expert in the subject matter and at the same time to be updated with the technology that emerged (Urusa & Sufiana, 2013). As educators are forced to do more online learning these days, it is important to gauge how much do they know about teaching with technology. Educators may know how to handle technology, however the question whether their teaching with technology is efficient is another thing. Due to the gap between generations, there have been studies that reported the educators' reluctance to integrate technology in their teaching and some of the reasons were due to limited computer literacy and lack of instructional designs when it comes to teaching with technology (Bawani, 2010). These reasons show that educators might lack the knowledge and understanding on the concepts of teaching with technology, and this is closely related to their level of technological pedagogical content knowledge (TPACK).

1.2 Problem Statement

There were a lot of previous studies that investigated the TPACK level among primary and secondary teachers. However, most of the studies were more focused on the pre-service teachers (Valtonen et al., 2017; Schmidt et al., 2009; Miguel-Revilla et al., 2020). TPACK studies investigating the in-service teachers were lacking, especially among English language teachers (Noor Illi et al., 2019). When it comes to the teachers' TPACK level, previous studies have established that teachers are more comfortable and confident in their pedagogical content knowledge (PCK) compared to their TPACK (Junnaina & Hazri, 2012; Ekrem & Recep, 2014; Nor'ain & Noor Zarinawaty, 2014; Köse, 2016). This shows that while teachers are experts in their subject matters, they are still not confident enough to teach subject matters using technology.

In Malaysia, the shift in education towards 21st century is evident as the Ministry of Education started to focus more on developing students who are not only excellent in core subjects, but also in the 21st century skills (Education Performance and Delivery Unit, [PADU] 2018). Hence, teachers in Malaysia need to step up their teaching, as in to include the 21st century skills in the teaching and learning process and at the same time to integrate technology as well. Integrating technology while teaching subject matters and 21st century skills to the students is not an easy task, hence it is crucial to investigate whether the in-service teachers in Malaysia have the necessary knowledge and skills to do so, based on the TPACK framework by Mishra and Koehler (2006). Therefore, this study aimed to develop an instrument that could investigate the teachers' level of TPACK in the context of 21st century skills teaching.

2. Literature Review

2.1 TPACK Areas of Studies

Since technology becomes a crucial tool in education, there a lot of researchers who conducted studies on TPACK among educators. There are different focuses on TPACK studies such as development and validation of TPACK instruments (Schmidt et al., 2009; Harris et al., 2010; Fisser et al., 2015; Hasniza & Tengku Faekah, 2016), perspectives/beliefs/readiness on TPACK (Fontanilla, 2015; Kim, 2018; Krauskopf & Forssell, 2018), TPACK level among educators (Akman & Guven, 2016; Köse, 2016; Walker, 2017; Nur Arifah et al., 2018), implementation of TPACK in teaching and learning (Srisawasdi, 2012; Tanak, 2018), and the most current is TPACK and 21st century skills (Valtonen et al., 2015; Valtonen et al., 2017; Shafie et al., 2019).

2.2 TPACK Instrument Studies

Schmidt et al. (2009) developed a self-assessment TPACK instrument for pre-service teachers based on Mishra and Koehler (2006) TPACK framework. Their study elaborated and discussed the development, validation, and reliability processes of the instrument. The validation process was conducted using the principal components factor analysis (PCA) and the reliability process was done using the Cronbach's Alpha analysis (Schmidt et al., 2009). Based on their development of instrument, it was adapted many times by various researchers who studied on TPACK. For example, Hasniza and Tengku Faekah (2016) in their study adapted their instrument and tested it in the Malaysian setting. They validated their adapted instrument using the confirmatory factor analysis (CFA) and using the Cronbach's alpha analysis for reliability. Through the validation and reliability processes, this study confirmed Schmidt's et al. (2009) instrument, as the CFA model fit their collected data, the reliability results were strong. Fisser et al. (2015) also asserted that the studies which adapted Schmidt's et al. (2009) could choose on which are they prefer to focus on such as on pedagogy, technology, or T-related knowledge domains. These studies showed that the instrument by Schmidt et al. (2009) is a reliable and valuable instrument to measure teachers' TPACK, hence this becomes the reason for this study to adapt this instrument as well on several selected domains.

2.3 TPACK and 21st Century Studies

These previous studies have established a strong foundation on the studies related to TPACK among educators all over the world. However, the studies related to TPACK and 21st century skills are still lacking, especially in Malaysia. Today, the focus of education is not only in mastering the core subjects such as science, mathematics, and languages, but also in possessing crucial 21st century skills (Soffel, 2016). Teachers today are not only teaching subject matters like mathematics, science, and language only; they also need to teach and train the students with the necessary 21st century skills like collaboration and communication (Trilling & Fadel, 2009). Educators also recognise the importance of teaching the 21st century skills to the students. This is to ensure that students are able to face complex 21st century challenges (Goradia, 2018) such as unemployment, as more jobs are becoming non-existent due to artificial intelligence. Therefore, nowadays researchers in the study area of TPACK start to shift their focus on the research of TPACK and 21st century skills.

Among the earliest study on TPACK and 21st century skills was by Valtonen et al. (2015). In their study, they highlighted the need to include and combine the 21st century skills into the TPACK framework, since these skills are being focused in education right now. Therefore, they developed an instrument to measure pre-service teachers' 21st century TPACK knowledge (Valtonen et al., 2015) which they named as TPACK-21. Miguel-Revilla et al. (2020) adapted their instrument to measure the trainee teachers' TPACK level in the context of teaching 21st century skills. The results of their study showed that the instrument of TPACK-21 is an excellent tool to be used in teacher training centres, and it measured the teachers' digital competence as intended. Therefore, based on these results, this study decided to also adapt the TPACK-21 questionnaire for some selected domains, along with the questionnaire from Schmidt et al. (2009).

3. Method

This section will elaborate on the research approach and design of the study and explain the target population, sample size, and sampling procedures. In addition, the instrument, data collection, and data analysis procedure will also be discussed accordingly.

3.1 Research Approach and Design

This study was conducted using the quantitative approach and employed the survey design. This method was appropriate and timely when conducted, due to the lockdown or the Movement Control Order (MCO) that happened in Malaysia during the data collection process. The MCO implementation in Malaysia took place for 2 years, as an effort by the Malaysian government to curb the spread of COVID19.

3.2 Target Population, Sample Size, and Sampling Procedure

In order to achieve the purpose of this study, the target population chosen was the English language teachers who are teaching in public secondary schools in one district in Selangor, Malaysia. The sample of this study was chosen through a probability sampling procedure,

specifically two-stage cluster sampling process. The first cluster sampling process involved the process of selecting a number of schools in the selected district. Then, another stage of cluster sampling was done by selecting a group of English language teachers in each selected school. The total sample size managed to be gathered in this study was 231 respondents.

3.3 Instrumentation

The instrument utilised in this study was a questionnaire which was adapted from the TPACK-21 instrument by Schmidt et al. (2009) and Valtonen et al. (2017). The TPACK-21 instrument measured pre-service teachers' TPACK level but focusing more on the 21st century skills rather than a learning subject. The instrument was adapted accordingly by including the English language subject and the 21st century skills that were focused on in this study which were critical thinking, creative thinking, communication, collaboration, and values and ethics (See Appendix). The 21st century skills were chosen following the 21st century skills framework by the Malaysian Education Performance and Delivery Unit (PADU) from the Ministry of Education.

3.4 Data Collection

The data collection process of this study was started by requesting for permission to conduct a study on the target population from the Malaysian Ministry of Education. Once the permission was granted, another permission was requested from the State Education Department of Selangor. The study then proceeded to contact the schools involved to get in contact with the principals and asked for permission to involve their teachers as respondents in this study. As permission was obtained, the teachers in charge were contacted, and the link to the questionnaire was given for them to share the link with the English language teachers. This study used online survey form, specifically the Google Form to gather data from the respondents.

3.5 Data Analysis

After the data collection process, this study conducted data cleaning process to ensure that the data used in this study were reliable. After the data cleaning process, data from 224 respondents were retained. Responses from 7 respondents had to be omitted due to several reasons. Therefore, the validity and reliability process of the instrument were done with these 224 data. For validity, this study chose to use the Content Validation Index (CVI) and the Content Validation Coefficient (CVC). Meanwhile, for reliability, the Cronbach's Alpha analysis was selected.

4. Results

4.1 Content Validity Index (CVI) Findings

Firstly, the content validity of the questionnaire was done using the CVI. The CVI was chosen as it is a commonly used metric to validate items in a questionnaire (Artino et al., 2014). This metric was also chosen due to its criteria that fit this study. To calculate the validity index of the

items, the calculations of I-CVI (for individual items) and S-CVI (for the items in total) were calculated accordingly.

The ratings for the experts to rate in this study were from 1 to 4 (1 – Not relevant, 2 – Quite relevant, 3 – Relevant, and 4 – Very relevant). Hence, to make the calculation of the CVI easier, the ratings of 1 and 2 were converted to 0, while the ratings for 3 and 4 were converted to 1. To calculate the I-CVI, the total number of experts in agreement was divided by the total number of experts involved in this study (Artino et al., 2014). Meanwhile, the S-CVI values were calculated by dividing the total I-CVI with the overall number of items (in this study, a total of 34 items), as well as dividing the number of agreements for each expert with the total number of items. The results of the I-CVI and S-CVI values are shown in Figure 1 below:

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Experts in agreement	I-CVI
TK1	1	1	1	1	1	1	6	1
TK2	1	1	1	1	1	1	6	1
TK3	1	1	1	1	1	1	6	1
TK4	1	1	1	1	1	1	6	1
TK5	1	1	1	1	1	1	6	1
CK1	1	1	1	1	1	1	6	1
CK2	1	1	1	1	1	1	6	1
CK3	1	1	1	1	1	1	6	1
CK4	1	1	1	1	1	1	6	1
CK5	1	1	1	1	1	1	6	1
PK1	1	1	1	1	1	1	6	1
PK2	1	1	1	1	1	1	6	1
PK3	1	0	1	1	1	1	5	0.83
PK4	1	1	1	1	1	1	6	1
PK5	1	1	0	1	1	1	5	0.83
PCK1	1	1	1	1	1	1	6	1
PCK2	1	1	1	1	1	1	6	1
PCK3	1	1	1	1	1	1	6	1
PCK4	1	1	1	1	1	1	6	1
PCK5	1	1	1	0	1	1	5	0.83
TPK1	1	1	1	1	1	1	6	1
TPK2	1	1	1	1	1	1	6	1
TPK3	1	1	1	1	1	1	6	1
TPK4	1	1	1	1	1	0	5	0.83
TPK5	1	1	1	1	1	1	6	1
TCK1	1	1	1	1	1	1	6	1
TCK2	1	1	1	1	1	1	6	1
TCK3	1	1	1	1	0	1	5	0.83
TCK4	1	1	1	1	1	1	6	1
TPACK1	1	1	1	1	1	1	6	1
TPACK2	1	1	1	1	1	1	5	1
TPACK3	1	1	1	1	1	0	5	0.83
TPACK4	0	1	1	1	1	1	4	0.83
TPACK5	1	1	1	1	1	1	6	1
Proportion Relevance	0.97	0.97	0.97	0.97	0.97	0.94	S-CVI/Ave 0.97	0.97

Figure 1. Number of Agreements and CVI Calculations from All Experts

Based on the Figure 1 above, it is shown that there were 7 items that did not get total agreement from the 6 experts involved. Hence, the total I-CVI score for these items was 0.83. The remaining 27 items obtained the value of 1.0 as all experts were in unison in regards to these items. Meanwhile, the S-CVI/Ave value for the whole questionnaire was 0.97. The S-CVI value for expert 6 was 0.94, as there were 2 items recorded that was not agreed by the him.

4.2 Content Validity Coefficient (CVC) Findings

The second type of metric used in this study to calculate was the Content Validity Coefficient, specifically using the Aiken's V formula. The reason to use the Aiken's V formula was to strengthen the validity of the questionnaire used in this study, since the questionnaire was adapted. This formula is also applicable to more than two raters/validators/experts as well as to both small and large samples (Aiken, 1980). The Aiken's V formula is shown as per below:

$$V = \sum s / n(c-1)$$

“V” is the experts' agreement index in total, “s” is the rating score of each individual expert subtracted by the lowest score of the rating, “n” is the total number of experts involved, and “c” is the total number of rating score/the highest rating score involved (Ikhsanudin & Subali, 2018; Anggraini et al., 2020; Widyaningsih et al., 2021). Different with the CVI calculation where the ratings were converted into 1 and 2, in CVC the ratings chosen by the experts were recorded as it is. The results of the CVC were shown in Figure 2 below:

Items	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	AIKEN'S V
TK1	4	4	4	4	4	2	0.89
TK2	4	4	4	4	4	3	0.94
TK3	4	4	4	4	4	4	1.00
TK4	4	4	4	4	4	3	0.94
TK5	4	4	4	4	4	3	0.94
CK1	4	4	4	4	4	4	1.00
CK2	4	4	4	4	4	4	1.00
CK3	4	4	4	4	4	3	0.94
CK4	3	4	4	4	4	4	0.94
CK5	3	3	4	3	4	4	0.83
PK1	4	4	4	4	4	4	1.00
PK2	4	4	4	4	4	4	1.00
PK3	3	4	3	4	4	3	0.83
PK4	4	4	4	4	4	4	1.00
PK5	4	2	3	4	4	4	0.83
PCK1	3	4	3	3	4	4	0.83
PCK2	3	4	3	3	4	4	0.83
PCK3	3	4	3	3	4	4	0.83
PCK4	3	4	3	3	4	4	0.83
PCK5	3	4	3	3	4	4	0.83
TPK1	4	3	4	4	3	4	0.89
TPK2	4	3	4	4	3	4	0.89
TPK3	4	3	4	4	3	4	0.89
TPK4	4	3	4	4	3	4	0.89
TPK5	4	3	4	4	3	4	0.89
TCK1	4	4	4	4	4	3	0.94
TCK2	3	4	4	4	3	3	0.83
TCK3	3	4	3	4	4	4	0.89
TCK4	4	4	4	4	4	2	0.89
TPACK1	4	4	4	4	4	3	0.94
TPACK2	4	4	4	3	4	2	0.83
TPACK3	4	4	4	4	4	2	0.89
TPACK4	3	3	4	4	3	4	0.83
TPACK5	4	4	4	4	3	2	0.83

Figure 2. CVC Calculations According to Aiken's V Formula

Figure 2 above shows the ratings of each expert and the CVC values for each item of the questionnaire. The ratings chosen by the expert ranged from 2 to 4. No expert rated any item with the rating score of 1 (Not relevant). Based on the calculations, the CVC values of all items ranged from 0.83 to 1.00. There were 6 items with a score of 1.0 and 7 items with a score of 0.94. Next, there were 9 items with a score of 0.89 and 12 items with a score of 0.83.

Apart from the CVI and the CVC calculations, this study also received some written comments and feedbacks from the experts. Most of the comments given were related to some grammar mistakes overlooked by this study, and some of the comments involved suggestion on words that needed to be replaced or omitted. Based on the comments received, the grammar mistakes and the word replacements were amended accordingly.

4.3 Reliability of the Instrument

Next, the reliability of the questionnaire in this study was analysed using the Cronbach's Alpha. Cronbach's Alpha is the most common parametric test used to check the reliability of an instrument. The Cronbach's Alpha analyses were conducted using the SPSS software version 26. The results of the analyses according to each dimension of TPACK are as per below:

Table 1. Results of Cronbach's Alpha analysis

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.966	.966	7

Table 1 above portrays the result of the Cronbach's Alpha analysis for all seven dimensions of TPACK (CK, PK, PCK, TCK, TPK, and TPACK). Based on the table, the result obtained was 0.97, which was a high and excellent value for reliability test.

5. Discussion

Muhammad Saiful Bahri (2019) compiled in his work the acceptable values for CVI values according to Lynn (1986), Polit and Beck (2006), and Polit et al. (2007) which showed that the acceptable CVI values for six to nine experts would be at least 0.83. Since the I-CVI and S-CVI values for all items in this study ranged from 0.83 to 1.0, hence all of the items in this study were valid. The high CVI values in this study also verified that most of the items were in line with the aim of the study (Noor Illi et al., 2019). The validity of the items in this instrument is crucial as it could help important stakeholders in education institutions such as administrators and educators themselves to measure their 21st century TPACK as a means to enhance their capability as educators in this era. The results of the CVI calculation suggest that this instrument could assist them to fulfil this purpose.

However, even though CVI is suitable to measure the content validity of a quantitative instrument (Bobos et al., 2020), this study decided to further strengthen its validity by computing the CVC values. The CVC values according to the Aiken's V formula, ranged from 0.83 to 1.00. For Aiken's V formula, if the index value of an item is more than 0.80, then the item is considered as valid (Ikhsanudin & Subali, 2018). Based on the results of the CVC calculation in Fig. 2, all items in this study were valid, hence strengthening the results of the CVI calculation above. The CVC measures the expert panels' judgements regarding the items' validity, which allows this study to quantitatively measure whether the items involved really represent the instrument's content domain and their clarity (Merino-Soto, 2018).

The validity of the questionnaire items in this study confirmed the validity of the questionnaires by Valtonen et al. (2017) and Schmidt et al. (2009) in which this study adapted from. In the study by Valtonen et al. (2017), they validated their questionnaire by the measure of confirmatory factor analysis (CFA) while by Schmidt's et al. (2009), they validated their questionnaire using factor analysis. Therefore, this study strengthened the validity of the two instruments from these two studies. Not only that, the Cronbach's Alpha analysis in this study also yielded a high reliability. This finding is consistent with the findings from the previous studies by Valtonen et al. (2017), Miguel-Revilla et al., (2020) and Noor Illi et al. (2019).

The instrument in this study was developed and adapted specifically for teachers who teach English language in schools. As suggested by Schmidt et al. (2009), it is relevant to have TPACK instrument that is specific for one subject matter, since the TPACK framework is dependent on the content of a subject. The use of an instrument specifically targeting English language and 21st century skills should enable a teacher to better reflect their strengths and weaknesses (Valtonen et al., 2017) in each 21st century TPACK dimension. Knowing their 21st century TPACK level will allow them to identify which area that they need to further work on to teach effectively.

6. Conclusion and Recommendation

The high validity and reliability of the instrument in this study showed that this instrument could be useful and valuable to measure teachers' TPACK when it comes to teaching 21st century skills. Furthermore, the instrument in this study focused more on measuring the in-service teachers' 21st century TPACK level, compared to other studies which aimed at studying the pre-service teachers. It is important to study the in-service teachers as well, as they are the ones who are currently in schools, teaching the students full time. The measurement of the teachers' 21st century TPACK level would help to identify which dimension that a teacher needs to improve in order to better teach the students 21st century skills using technology.

This study has conducted the content validity and reliability of 21st century TPACK instrument using the CVI, CVC, and Cronbach's Alpha and it was proven that the instrument is a valid and reliable instrument to be used. Since this instrument was adapted from the studies by Valtonen et al. (2017) and Schmidt's et al. (2009), it is quite new and not widely

used yet. It is recommended for future researchers to use this instrument in their studies for various purposes such as teachers' level of 21st century TPACK, significant differences between the 21st century TPACK level among different groups of age, teaching experience, level of education, and others. Apart from that, it is also recommended to use different types of validity and reliability tests to measure this instrument. It is hoped that with the use of this instrument, improvement in teaching and learning process among English language teachers in schools could be done accordingly.

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Appendix A
21st Century TPACK Instrument

No.	Items
Technological Knowledge (TK)	
1.	I can solve ICT related problems.
2.	I am familiar with new technologies and their features.
3.	I keep up with important new technologies.
4.	I have the technical skills I need to use technology.
5.	I know about a lot of different technologies.
Content Knowledge (CK)	
6.	I have sufficient knowledge in developing contents in English language subject.
7.	I know the basic theories and concepts of English language subject.
8.	I know the history and development of important theories in English language subject.
9.	I am familiar with recent research in English language subject.
10.	I have various ways and strategies of developing my understanding of English language subject.
Pedagogical Knowledge (PK)	
11.	I know how to assess students' performance in a classroom.
12.	I can adapt my teaching style to different learners.
13.	I can assess students' learning in multiple ways.
14.	I can use a wide range of teaching approaches in classroom setting.
15.	I know how to organize and maintain classroom management.
Pedagogical Content Knowledge (PCK)	

16.	In teaching English language subject, I know how to guide students to communicate with each other.
17.	In teaching English language subject, I know how to guide students' critical thinking.
18.	In teaching English language subject, I know how to guide students to collaborate with each other in group work.
19.	In teaching English language subject, I know how to guide students' creative thinking.
20.	In teaching English language subject, I know how to guide students in learning values and ethics.
Technological Pedagogical Knowledge (TPK)	
21.	I know how to use ICT in teaching as a tool to stimulate students' critical thinking
22.	I know how to use ICT in teaching as a tool to stimulate students' creative thinking.
23.	I know how to use ICT in teaching as a tool for students to collaborate with each other.
24.	I know how to use ICT in teaching as a tool for students to communicate.
25.	I know how to use ICT in teaching as a tool to teach values and ethics to students.
Technological Content knowledge (TCK)	
26.	I know websites with online materials for teaching English language subjects and 21 st century skills.
27.	I know ICT-applications which are used by professionals in teaching English language subjects and 21 st century skills.
28.	I know ICT applications which I can use to better understand the contents of English language subjects and 21 st century skills.
29.	I know which technologies I can use to illustrate difficult contents in teaching English language subjects and 21 st century skills.
Technological Pedagogical Content Knowledge (TPACK)	
30.	I can teach lessons that appropriately combine English language, technologies, 21 st century skills, and teaching approaches.

31.	I can select technologies to enhance what I teach, how I teach, and what students learn in English language class.
32.	I can use strategies that combine content, technologies, 21 st century skills, and teaching approaches in English language class.
33.	I can provide leadership in helping others to coordinate the use of content, technologies, 21 st century skills, and teaching approaches at my school.
34.	I can choose technologies that enhance the content for English language lesson and 21 st century skills.

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