Impact of pre-service teachers' gaming behaviours on their confidence and competence in applying game-based learning approaches: Implications for Teacher Educators

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Abstract: Despite the increased popularity of Game-based Learning (GBL), there is still a lack of empirical evidence supporting GBL as an approach and the need for ongoing research is widely advocated (Hainey et al., 2016). In particular, the area of teacher education in GBL is identified as an area of research that warrants increased attention. According to Foster, Shah & Duvall (2015), teachers' in-ability to use GBL is compounded by the lack of teacher education or professional learning programmes that focus on developing teacher confidence and competence in adopting GBL, particularly at the pre-service level. Accepting the belief that pre-service teacher education has a strong influence on teachers' use of technology in their practice (Hammond et al, 2009), and acknowledging that a significant variable in teacher acceptance and adoption of GBL in the classroom is the teacher's own prior experience with gaming (Becker and Jacobsen 2005); this research investigates how pre-service teachers' gameplay behaviours influenced their confidence and competence towards using GBL. It also examines the implications of pre-service teachers' confidence and competence towards using GBL approaches for teacher educators and the design of pre-service teacher education programs in GBL.

Introduction

It is generally accepted that teacher confidence and competence in the use of digital technologies inevitably influences how, when and for what purposes they use digital technologies in their classrooms (Murthy, Iyer & Warriem, 2015; Blau & Shamir-Inbal, 2017; Brevik et al., 2019). Over the past two decades, there has been increasing research interest in how digital games can be used to support learning within the formal settings of schools and curricula. However, despite the increased popularity of Game-based Learning (GBL), there is still a lack of empirical evidence supporting GBL as an approach and the need for ongoing research is widely advocated (Hainey et al., 2016). In particular, the area of teacher education in GBL is identified as an area of research that warrants increased attention (Foster, Shah & Duvell, 2015; Takeuchi & Vaala, 2014). This research gap is significant in the Irish context given that most recent surveys report teachers as feeling inadequately prepared for the task of integrating technology-based approaches including digital GBL into their classrooms (Kenny & McDaniel, 2011; Cosgrove et al., 2019).

According to Foster, Shah & Duvall (2015), teachers' in-ability to use GBL is compounded by the lack of

teacher education or professional learning programmes that focus on developing teacher competence in adopting GBL, particularly at the pre-service level. They argue that in order to confidently and effectively embed GBL, teachers need a "systematifoundation in game-based learning that acknowledges these issues and empowers them with the skills to incorporate games in their praxis" (p383). However, it is accepted that research is the area is lacking and there are calls for comprehensive teacher education in GBL (e.g. Li, 2013). There are also few studies which focus on pre-service teacher education in GBL

Accepting the belief that pre-service teacher education has a strong influence on teachers' use of technology in their practice (Hammond et al, 2009), and acknowledging that a significant variable in teacher acceptance and adoption of GBL in the classroom is the teacher's own prior experience with gaming (Becker and Jacobsen 2005); this research was conducted to examine the implications of pre-service teachers' confidence and competence towards using GBL approaches for teacher educators and the design of pre-service teacher education programs in GBL. In this research study, GBL is considered an approach to present a subject matter by using game-like features and environment, facilitating students' learning outcomes, engagement and motivation (Dennis, 2016; Gee, 2003; Shaffer, 2006). The research questions were:

1. Is there a significant difference in confidence in using game-based learning approach among pre-service teachers with different gaming behaviours (gameplay experience, weekly frequency, platforms and game genres)?
2. Is there a significant difference in competence in using game-based learning approach among pre-service teachers with different gaming behaviours (gameplay experience, weekly frequency, platforms and game genres)?
3. What are the implications for the design of GBL focused learning experiences for pre-service teachers in initial teacher education?

Literature Review

While there has been increasing research interest in game-based learning (GBL) in primary education (Acquah & Katz, 2020; Li & Tsai, 2013), research in the area is still regarded as emerging. In particular, the need for further research on teacher education in GBL is strongly argued (Foster, Shah & Duvell, 2015; Hainey et al., 2016; Takeuchi & Vaala, 2014), with a number of studies reporting teachers as feeling inadequately prepared for the task of incorporating GBL into their classrooms (Cosgrove et al., 2019; Takeuchi & Vaala, 2014). For example, in a study conducted by Kamışlı (2019), 99.2% of 410 primary school teachers reported their willingness to use GBL but 98.8% of them felt incompetent to use games in their classroom practice.

The positive association between gameplay experience and the acceptance of digital games as educational resources was articulated by Martín del Pozo, Basilotta Gómez-Pablos, & García-Valcárcel Muñoz-Repiso (2017). Their study statistically indicated that pre-service primary teachers who have played digital games for more years have more positive attitudes to using video games for education. They also found that pre-service teachers who play more frequently had a significant higher positive attitude on the use of video games for education. In addition, the male pre-service teachers had statistically more positive attitudes compared to the female cohort Some studies have further indicated that pre-service teachers who play digital games for their own pleasure have been evidenced to have significantly higher levels of confidence and competence in using GBL in their classroom practice (Blume, 2019; Hsu & Chiou, 2019). However, research in relation to pre-service teacher's gameplay behaviour (e.g. gameplay years, frequency, platforms and game genres) and its impacts on their confidence and competence in using GBL is limited.

Accepting that i) teacher confidence and competence in the use of digital technologies inevitably influences how, when and for what purposes they use digital technologies in their classrooms (Murthy, Iyer & Warriem, 2015; Blau & Shamir-Inbal, 2017; Brevik et al., 2019); ii) a significant variable in teacher acceptance and adoption of GBL in the classroom is the teacher's own prior experience with gaming (Becker and Jacobsen 2005); and, iii) pre-service teacher education has a strong influence on teachers' use of technology in their practice (Hammond et al, 2009), the research reported in this paper sought to examine the impact of pre-service teachers' gaming behaviours on their confidence and competence in applying game-based learning approaches.

Methodology

This section outlines the participants in the study, the measurement tools that were developed and the data analysis methods employed.

Participants

Participants in this study were final year pre-service teachers in the Bachelor of Education programme in Dublin City University. Convenience sampling techniques were used to recruit participants to complete an anonymous self-administered quantitative survey. From a year group of 404 a total of 344 participants, completed a questionnaire that aimed to assess their gaming behaviour and measure their levels of competence and confidence in using GBL approaches. Of the participants, 53 (15%) were men, and 291 (85%) were female.

Development of measurement tools

We developed two questionnaires with 5-point Likert-type scale items to measure pre-service teachers' confidence and competence in GBL. Our measurement development comprised two stages: the first stage was to search related questionnaires and create the draft questionnaires, while the second stage was to have the drafts reviewed by external reviewers. The draft confidence questionnaire conceptually drew upon the computer technology integration survey proposed by Wang, Ertmer, and Newby (2004) and the questionnaire of teacher self-efficacy of using digital games developed by An and Cao (2017). The draft version of the competence measurement conceptually drew upon the Technological Pedagogical Content Knowledge scale developed by Yurdakul et al. (2012). To ensure the questionnaire quality, we invited two external reviewers. The first reviewer was an American-based professor with expertise in GBL. The second reviewer was an Irish-based professor with expertise in teaching and learning with digital technologies. Based on their feedback, we revised the two questionnaires and conducted internal reliability analysis. The Cronbach's alpha coefficient of the confidence of the GBL questionnaire is 0.916, while the value of the competence questionnaire is 0.796. There were 12 items for confidence and six items included for the competence measurement in the final questionnaires. The participants were also asked to provide background information, in relation to gender, gameplay behaviour including gameplay experience, weekly gameplay hours, number of platforms used as well as game genres used.

Data analysis

The methods of categorising the respondents' gameplay experience, weekly gameplay frequency, platform number, and genre number were as follows:

1. Gameplay experience: three groups of pre-service teachers were defined: non-gamer, short-term gamer (gameplay experience <= ten years), and long-term gamer (gameplay experience > ten years). The cut off between short-term and long-term gamer groups is the median of game years in all gamers. This was ten years.
2. Weekly gameplay frequency: the pre-service teachers were categorised as three groups: non-gamer, occasional gamer (weekly gameplay hour = one hour), and frequent gamer (weekly gameplay hour >= two hours). The cut off between the occasional and frequent gamer groups is the median of weekly gameplay hours in all gamers. This was one hour.
3. Gameplay platform number: three groups of pre-service teachers were defined by gameplay platform number (e.g. console, mobile device or computer/laptop): non-gamer, single-platform gamer (platform number = one), and cross-platform gamer (platform number >= two). The cut-off between the single-platform and cross-platform gamer groups is the median of gameplay platform numbers in all gamers. This was one platform.
4. Gameplay genre number: the pre-service teachers were categorised as three groups: non-gamer, less-genre gamer (game genre <= two), and multi-genre gamer (game genre >= three). The cut-off between the less-genre gamer and the multi-genre gamer groups is the median of all gamers' gameplay genre numbers. This was one two genres.

The Kruskal-Wallis test results were performed to compare the pre-service teachers' confidence and competence in GBL. The post-hoc Mann-Whitney tests using a Bonferroni-adjusted alpha level of .017 (0.05/3) were also applied.

Results

Survey findings relating to the confidence and competence levels of the pre-service teachers in using a game-based learning approach are presented as follows:

GBL confidence and competence comparison by gameplay experience.

Three groups of pre-service teachers were categorised as 134 non-gamers, 108 short-term gamers, and 102 long-term gamers. Figure 1 below illustrates the pre-service teachers' means of confidence and competence regarding gameplay experience. A Kruskal-Wallis test result showed that there was a significant difference in the mean confidence for the non-gamer group (M = 2.67, SD = 0.67), short-term gamer group (M = 2.97, SD = 0.62) and the long-term gamer group (M = 3.15, SD = 0.64); $H(2) = 30.08$, $p < .001$, effect size $d = 0.60$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean confidence between the non-gamer and short-term gamer groups was significant ($p < .017$). The difference in mean confidence between the non-gamer and long-term gamer groups was significant ($p < .00017$). There was no significant difference in the mean confidence levels between the short-term gamer and long-terms gamer groups ($p = .035$).

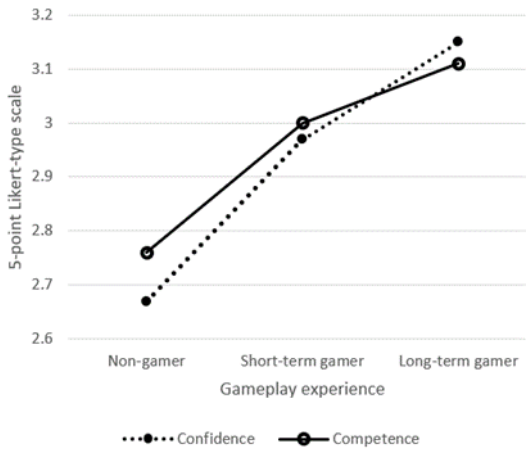

Figure 1. Confidence and Competence by Gameplay Experience

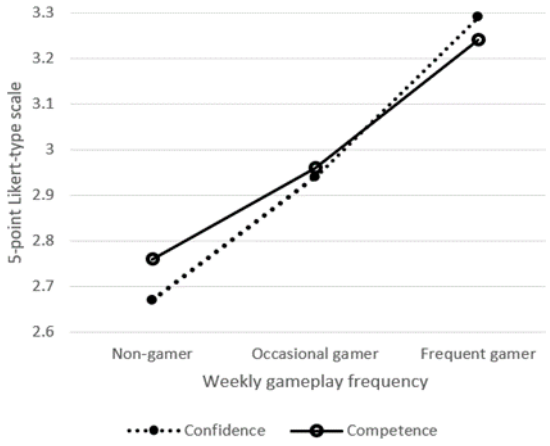

Figure 2. Confidence and Competence by Weekly Gameplay Frequency

A Kruskal-Wallis test result revealed that there was a significant difference in the mean competence for the non-gamer group (M = 2.76, SD = 0.64), short-term gamer group (M = 3.00, SD = 0.59) and the long-term gamer group (M = 3.11, SD = 0.62); $H(2) = 19.16$, $p < .001$, effect size $d = 0.46$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean competence between the non-gamer group and short-term gamer group was significant ($p < .017$). The difference in mean competence between the non-gamer group and long-term gamer group was also significant ($p < .00017$). There was no significant difference in the mean confidence levels between the short-term gamer and long-term gamer groups ($p = .137$).

GBL confidence and competence comparison by weekly gameplay frequency

Three groups of pre-service teachers were defined as 134 non-gamers, 142 occasional gamers, and 102 frequent gamers. Figure 2 above illustrates the pre-service teachers' means of confidence and competence regarding weekly gameplay frequency. A Kruskal-Wallis test result demonstrated that there was a significant difference in the mean confidence for the non-gamer group (M = 2.67, SD = 0.67), occasional gamer group (M = 2.94, SD = 0.62) and the frequent gamer group (M = 3.29, SD = 0.61); $H(2) = 37.82$, $p < .001$, effect size $d = 0.69$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean confidence between the non-gamer group and occasional gamer group was significant ($p < .017$). The difference in mean confidence between the non-gamer group and frequent gamer group was significant ($p < .00017$). The difference in mean confidence between the occasional gamer and frequent gamer groups was also significant ($p < .0017$).

A Kruskal-Wallis test result showed that there was a significant difference in the mean competence for the non-gamer group (M = 2.76, SD = 0.64), occasional gamer group (M = 2.96, SD = 0.60) and the frequent gamer group (M = 3.24, SD = 0.57); $H(2) = 28.46$, $p < .001$, effect size $d = 0.58$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean competence between the non-gamer group and occasional gamer group was significant ($p < .017$). The difference in mean competence between the non-gamer group and frequent gamer group was significant ($p < .00017$). The difference in mean competence between the occasional gamer and frequent gamer groups was also significant ($p < .0017$).

GBL Confidence and competence comparison by gameplay platform number

Three groups of pre-service teachers were defined as: 134 non-gamer group, 80 single-platform gamers, and 130 cross-platform gamers. Figure 3 below illustrates the pre-service teachers' means of confidence and competence regarding gameplay platform numbers. A Kruskal-Wallis test result indicated that there was a significant difference in the mean confidence for the non-gamer group (M = 2.67, SD = 0.67), single-platform gamer group (M = 2.94, SD = 0.61) and the cross-platform gamer group (M = 3.13, SD = 0.64); $H(2) = 30.06$, $p < .001$, effect size $d = 0.60$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean confidence between the non-gamer group and single-platform gamer group was significant ($p < .017$). The difference in mean confidence between the non-gamer group and long-term gamer group was significant ($p < .00017$). However, there was no significant difference in the mean confidence levels between the single-platform gamer and cross-platform gamer groups ($p = .035$).

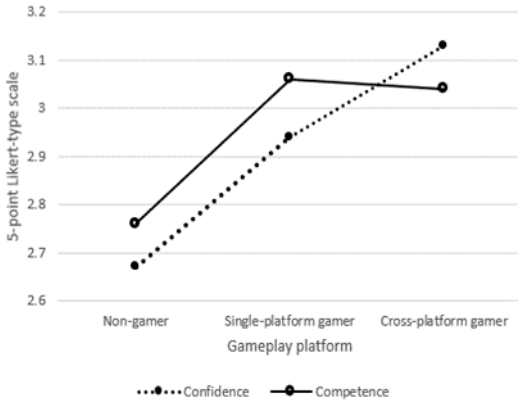

Figure 3. Confidence and Competence by Gameplay Platform Number

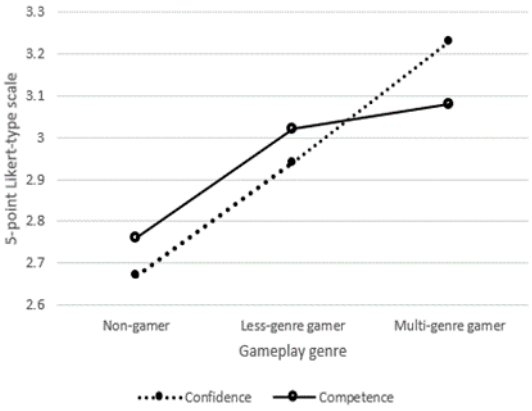

Figure 4. Confidence and Competence by Game Genre Number

A Kruskal-Wallis test result showed that there was a significant difference in the mean competence for the non-gamer group (M = 2.76, SD = 0.64), single-platform gamer group (M = 3.06, SD = 0.50) and the cross-platform gamer group (M = 3.04, SD = 0.66); $H(2) = 17.09$, $p < .001$, effect size $d = 0.43$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean competence between the non-gamer group and short-term gamer group was significant ($p < .017$). The difference in mean competence between the non-gamer group and cross-platform gamer group was significant ($p < .00017$). However, there was no significant difference in the mean confidence levels between the single-platform gamer and cross-platform gamer groups ($p = .699$).

GBL Confidence and competence comparison by game genre number

Three groups of pre-service teachers were defined as: 134 non-gamers, 122 less-genre gamers, and 88 multi-genre gamers. Figure 4 above illustrates the pre-service teachers' means of confidence and competence regarding gameplay genre number. A Kruskal-Wallis test result demonstrated that there was a significant difference in the mean confidence for the non-gamer group (M = 2.67, SD = 0.67), less-genre gamer group (M = 2.94, SD = 0.62) and the multi-genre gamer group (M = 3.23, SD = 0.62); $H(2) = 36.19$, $p < .001$, effect size $d = 0.67$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean confidence between the non-gamer group and less-genre gamer group was significant ($p < .0017$). The difference in mean confidence between the non-gamer group and multi-genre gamer group was significant ($p < .00017$). The difference in mean confidence between

the less-genre gamer and multi-genre gamer groups was also significant ($p < .0017$).

A Kruskal-Wallis test result indicated that there was a significant difference in the mean competence for the non-gamer group (M = 2.76, SD = 0.64), less-genre gamer group (M = 3.02, SD = 0.58) and the multi-genre gamer group (M = 3.08, SD = 0.64); $H(2) = 17.87$, $p < .001$, effect size $d = 0.44$. The post-hoc Mann-Whitney tests were used to compare all pairs of groups. The difference in mean competence between the non-gamer group and less-genre gamer group was significant ($p < .0017$). The difference in mean competence between the non-gamer group and multi-genre gamer group was significant ($p < .00017$). However, there is no significant difference in mean competence between the less-genre gamer and multi-genre gamer groups.

Discussion and Conclusion

This study empirically found that pre-service teachers' gaming behaviour have significantly impacted on their confidence and competence of using GBL in in a range of different ways. These findings have implications for the design and development of preservice teacher education programmes particularly with regards to the design and development of GBL learning experiences for classroom learning, teaching and assessment.

First, the effect of gameplay experience on the pre-service teachers' mean differences in GBL confidence and competence only existed between the non-gamer and the short-term gamer groups as well as between the non-gamer group and the long-term gamer groups. However, there was no significant confidence and competence mean difference between the short-term gamer and long-term gamer groups. This is encouraging news for teacher educators as it suggests that if we can provide appropriate gameplay opportunities for our non-gamer students, this will optimise the impact we can have on improving their confidence and competence in relation to GBL.

Second, findings in relation to the effect of weekly gameplay frequency, not surprisingly the frequent gamer group had the highest means of confidence and competence in using GBL, the occasional gamer group had medium means of confidence and competence and the non-gamer had the lowest mean of confidence and competence. Taking the findings in relation to gameplay frequency in conjunction with those relating to amount of gameplay experience suggests that a short-term but frequent exposure of gameplay experience might be helpful for pre-service teachers' development in confidence and competence. This finding is particularly important for us as teacher educators as we considered how best to design a module focusing on GBL in order to maximise the potential impact on developing our preservice teachers' confidence and competence in using GBL in primary classrooms.

Similarly, the number of gameplay platforms used had an effect on the competence and confidence of the students in using GBL. The pattern that emerged was as expected, in that the non-gamer group had the lowest mean for both GBL confidence and competence. However, what is interesting is that the single-platform gamer and cross-platform gamer groups had no significant difference in their means of confidence and competence in GBL. This would suggest that there are no substantial benefits to be gained from using a range of platforms for gameplay with preservice teachers.

Finally, the number of gameplay genres used had an effect on the competence and confidence of the students in using GBL. Again as expected, the non-gamer group had both the lowest means of confidence and competence towards using GBL. The multi-genre gamer group had the highest mean of confidence in GBL whereas the less-genre gamer had a medium level of confidence. In addition, there was no significant difference between those who used no more than two gaming genres and those who were multi-genre gamers.

These findings suggest that rather than investing time and money on providing a range of gaming platforms, the focus should instead be on providing opportunities for preservice teachers to experience at least two genres of games to develop preservice teachers' GBL confidence and competence.

To conclude, the findings from this study have important implications for informing teacher educators about the future design and development of more effective programmes for pre-service teacher education to support the use of GBL in primary classrooms for learning, teaching and assessment. Based on these findings, we recommend that when designing programmes to develop preservice teachers' confidence and competence in relation to GBL, there should be short-term (at least one semester) but frequent exposure of gameplay experience, using one platform but with a focus on using at least two different genres of games.

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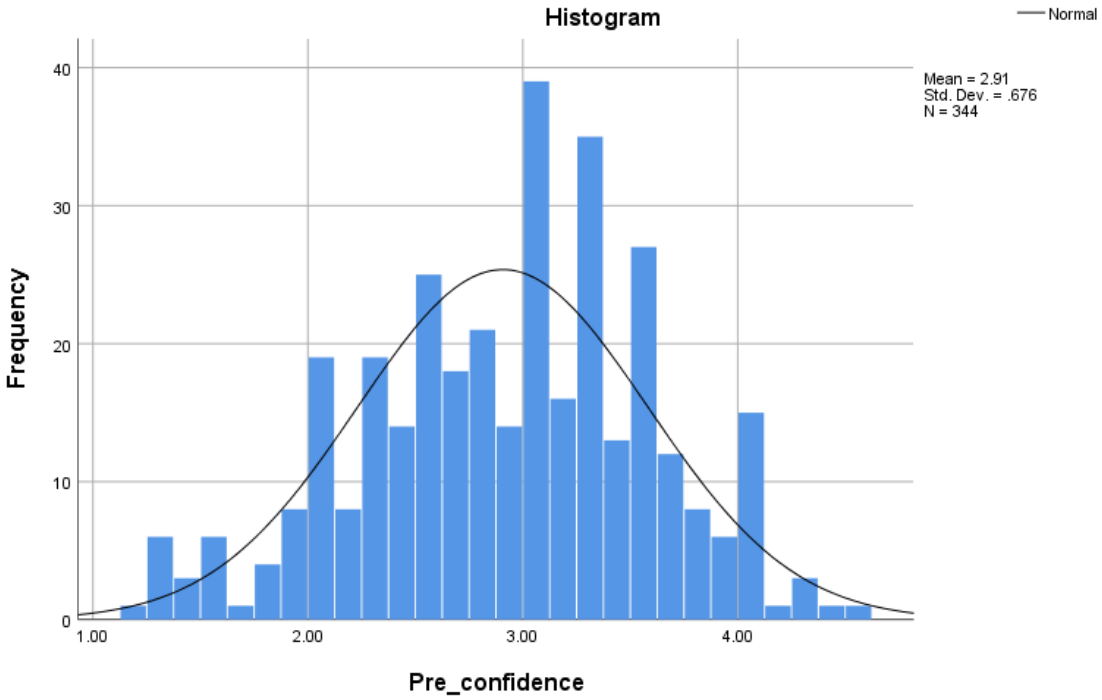
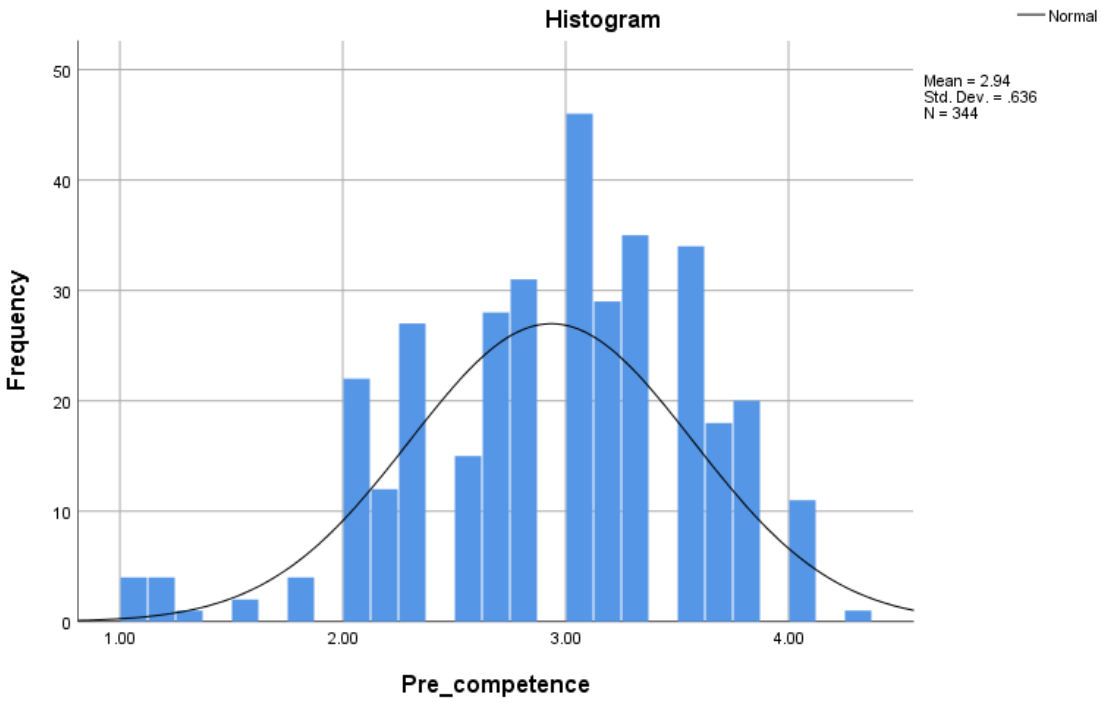
Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre_confidence	.069	344	.000	.989	344	.010
Pre_competence	.104	344	.000	.966	344	.000

a. Lilliefors Significance Correction




Histogram
Normal
Mean = 2.94
Std. Dev. = .636
N = 344
Frequency
50
40
30
20
10
0
1.00
2.00
3.00
4.00
Pre_competence